JANUARY, 1950

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SPECIALIZED FOR REFINING, NATURAL GASOLINE, AND PETRO-CHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

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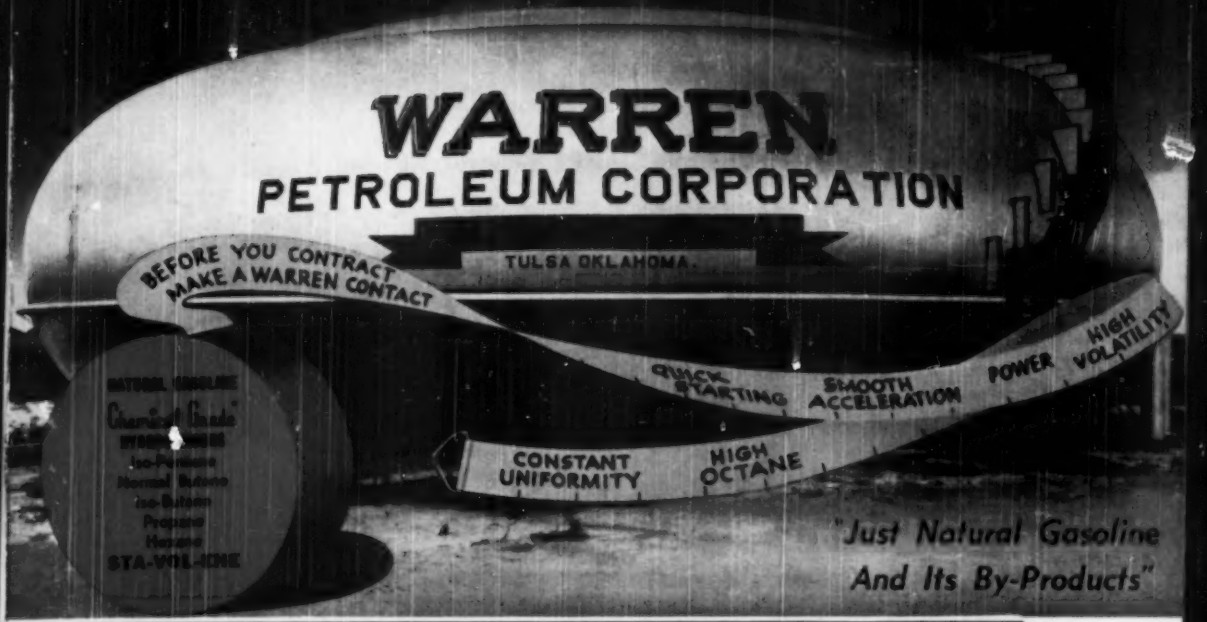
.... Made to Winter's Measure



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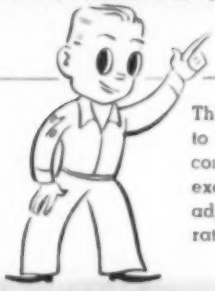

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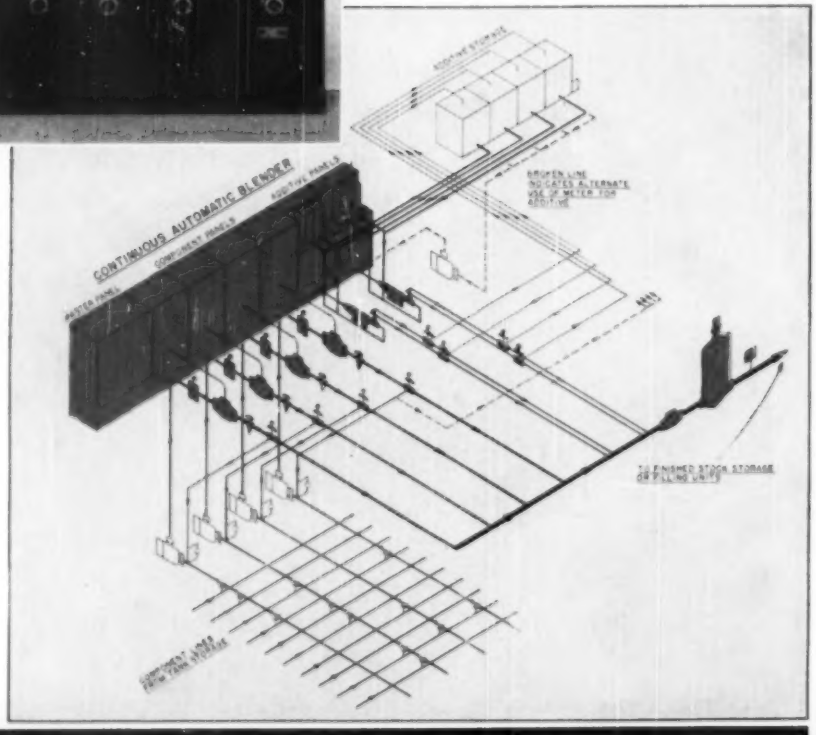

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PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President — A. L. BURNS, General Manager

VOLUME 29, NO. 1 — JANUARY, 1950

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ELBOWS—90° Short Radius	1"-30"	1½"-30"				
ELBOWS—45° Long Radius	½"-30"	¼"-30"	1"-12"	¼"-8"	4"-24"	½"-12"
RETURNS—180° Long Radius	½"-24"	½"-24"	1"-12"	2"-8"	4"-24"	½"-12"
RETURNS—180° Short Radius	1"-30"	1½"-30"				
RETURNS—180° Extra Long Radius	1"-2½"	1"-2½"				
TEES—Straight	½"-24"	½"-24"	½"-12"	½"-8"		
TEES—Reducing Outlet	½"-24"	½"-24"	¼"-12"	¼"-8"		
REDUCERS—Concentric and Eccentric	¼"x½"-24"x 20"	¼"x½"-24"x 20"	⅜"x¼"-12"x 10"	⅜"x¼" 8"x 6"		
CAPS	½"-24"	½"-24"	1"-12"	1"-8"		
STUB ENDS—Lap Joint	½"-24"	½"-24"				
SADDLES	2"-24"**					
LATERALS—Straight	1"-24"	1"-24"				
LATERALS—Reducing-on-run	1"-24"	1"-24"				
CROSSES—Straight and Reducing	½"-24"	½"-24"				
RINGS—Welding, Grove Type	½"-24"	1"-24"		1½"-8"		
RINGS—Welding, Ridge Type	½"-12"	½"-12"				
SLEEVES—Welding	2"-24"**					

** Since saddles and sleeves are for external reinforcement only, they do not conform to iron pipe size thicknesses.

TUBE-TURN FORGED STEEL FLANGES — RANGE OF SIZES

DESCRIPTION	150 LB.	300 LB.	400 LB.	600 LB.	900 LB.	1500 LB.	2500 LB.
WELDING NECK	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"	½"-24"	½"-12"
SLIP-ON	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-24"	½"-12"
LAP JOINT	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-24"	½"-12"
THREADED	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-12"	½"-12"
BLIND	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-24"	½"-12"
SOCKET TYPE	½"-24"	½"-4"	½"-3½"†	½"-3½"			
REDUCING—Threaded or Slip-On	½"-24"	½"-24"	½"-24"†	½"-24"	½"-24"*	½"-12"	½"-12"
ORIFICE—Threaded		1"-24"	4"-12"	4"-12"	3"-12"	1"-12"	
ORIFICE—Slip-On		1"-24"					
ORIFICE—Welding Neck		1"-24"	4"-12"	1"-12"	3"-12"	1"-12"	

† Dimensions on sizes thru 3½" same as for 600 lb. flanges.
* Dimensions on sizes thru 2½" same as for 1500 lb. flanges.

In addition to carbon steel welding fittings and flanges listed here, the complete Tube-Turn line embraces many other metals and alloys—types 304, 347, and 316 stainless steel, carbon moly and chrome moly steels, copper, aluminum, brass, Monel Metal, Inconel, nickel, wrought iron. Ask your Tube-Turn distributor for catalogs and other reference material.

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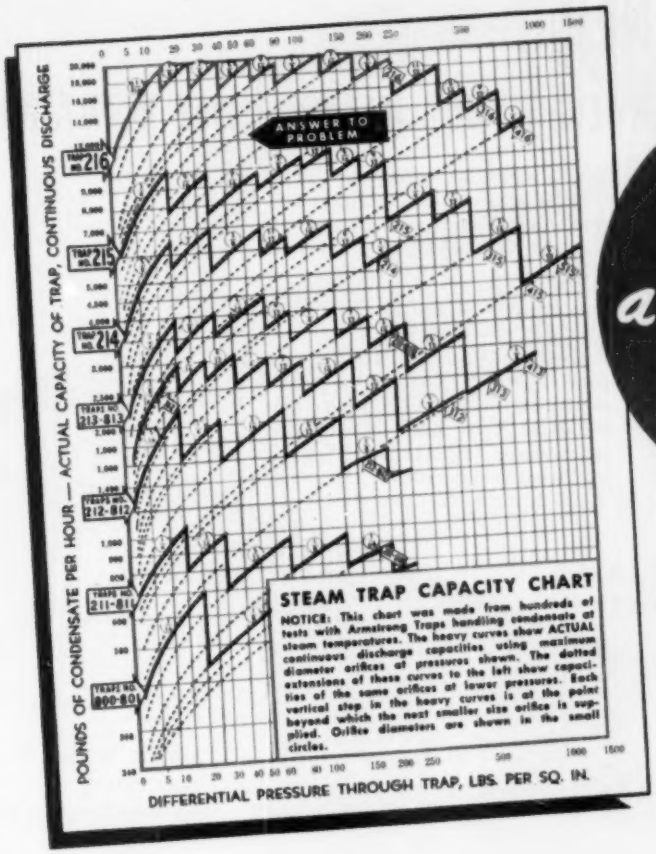
ANSWER TO PROBLEM
STEAM TRAP CAPACITY CHART
NOTICE: This chart was made from hundreds of tests with Armstrong Traps handling condensate at steam temperatures. The heavy curves show ACTUAL continuous discharge capacities using maximum diameter orifices at pressures shown. The dotted extensions of these curves to the left show capacities of the same orifices at lower pressures. Each vertical step in the heavy curves is at the point beyond which the next smaller size orifice is supplied. Orifice diameters are shown in the small circles.
POUNDS OF CONDENSATE PER HOUR — ACTUAL CAPACITY OF TRAP, CONTINUOUS DISCHARGE
DIFFERENTIAL PRESSURE THROUGH TRAP, LBS. PER SQ. IN.

BECAUSE good trapping starts with selection of the right trap for the job, Armstrong has provided all the data necessary for correct trap selection in the Armstrong Steam Trap Book. The Capacity Chart reproduced here is taken from this handy reference work. By means of this chart, any engineer can select the correct traps for his requirements. Here is a typical problem showing how the chart is used:

Given: An evaporator condensing 6000 lbs/hr at 50 psi when the steam is first turned on, but condensing only 1000 lbs/hr at 150 psi at the end of the process. Safety factor of 2 to 1 required at the *minimum* pressure differential.

Solution: Referring to the chart, the No. 216 Armstrong Trap with 7/16" orifice for 150 psi pressure has a capacity of 12,000 lbs/hr at 50 psi. This provides for the 2 to 1 safety factor and is, therefore, the correct trap for the job.

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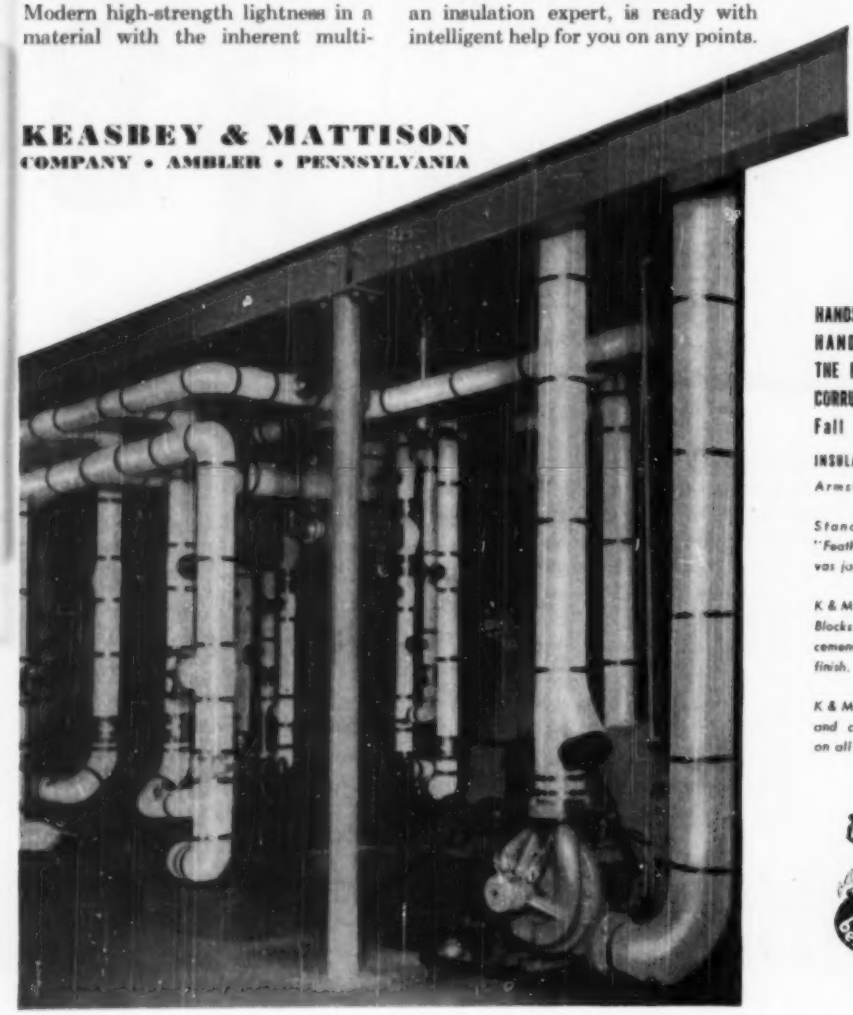

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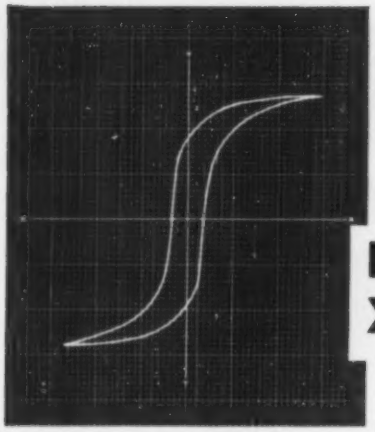

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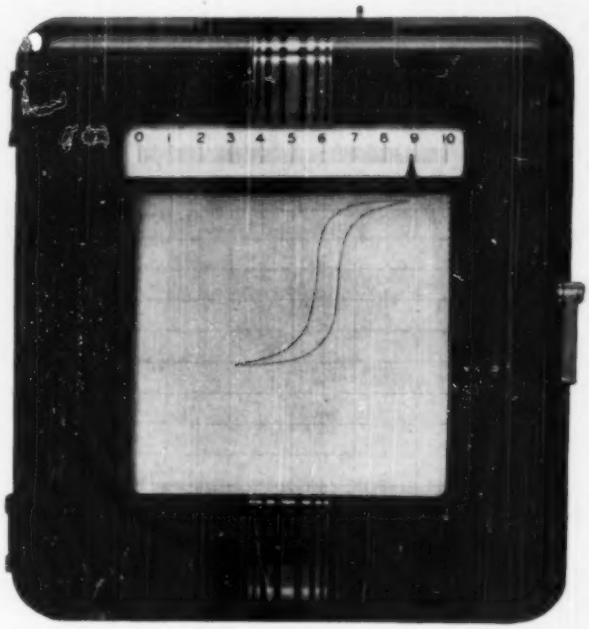

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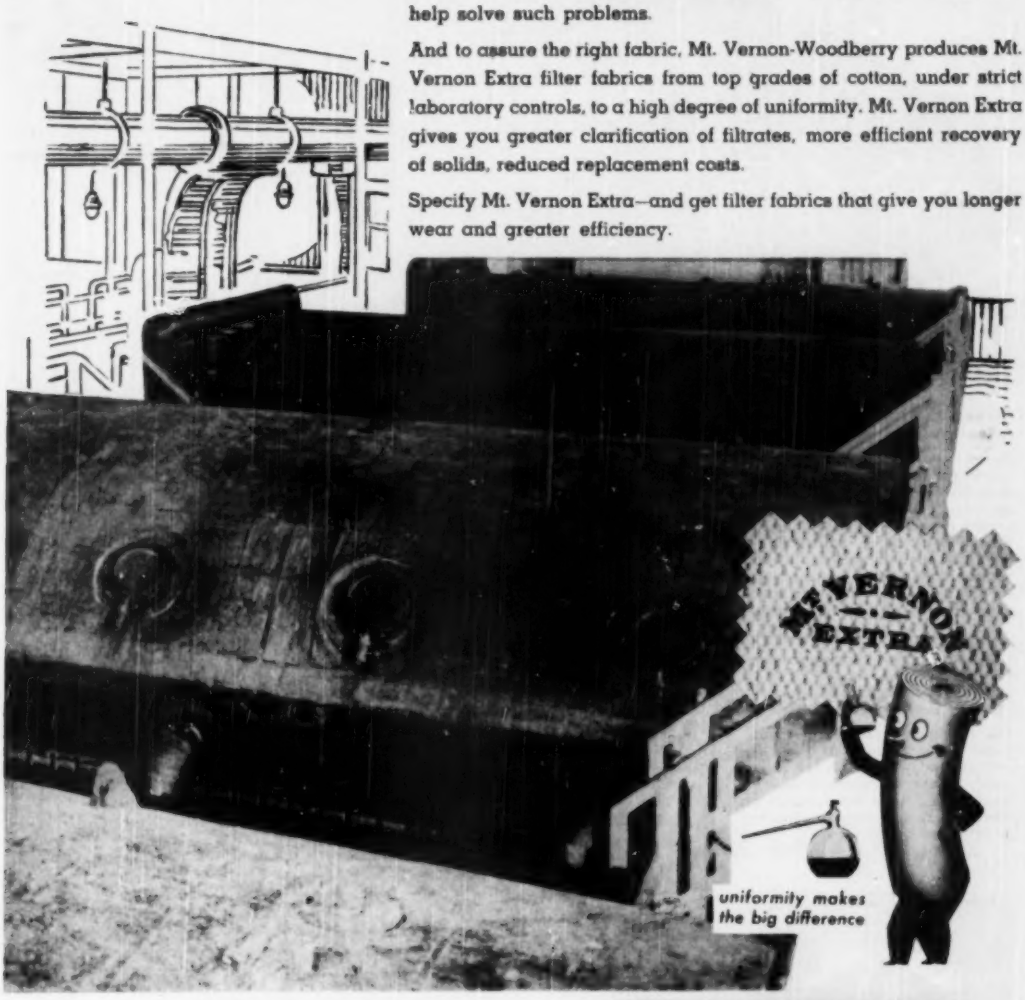

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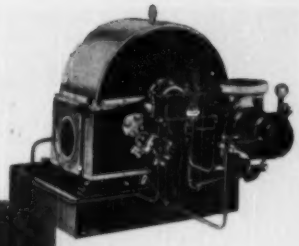
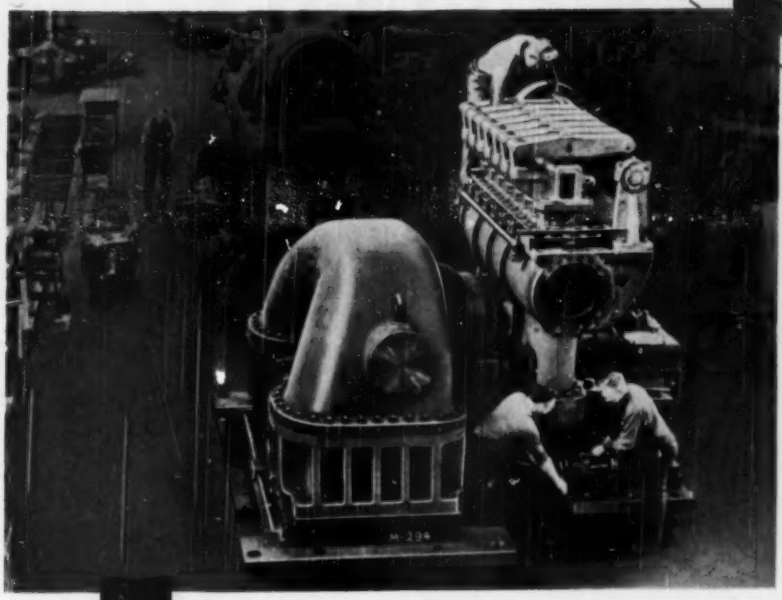


FROM SMALLEST SINGLE-STAGE TO MULTI-STAGE GIANTS



A standout for size. One of two Worthington 24,000 hp centrifugal compressor-drive turbines during assembly.

Worthington Turbines Meet the Broadest Range of Drive Requirements

Worthington Turbines offer you unlimited choice of sizes and types — including straight condensing, straight non-condensing, extraction, mixed pressure extraction, low pressure and high back pressure. Steam or gas driven, for mechanical or generator drive, all are available with governors for constant or variable speed, with optional governor-control.

LOWER-COST BLOWER AND COMPRESSOR OPERATION

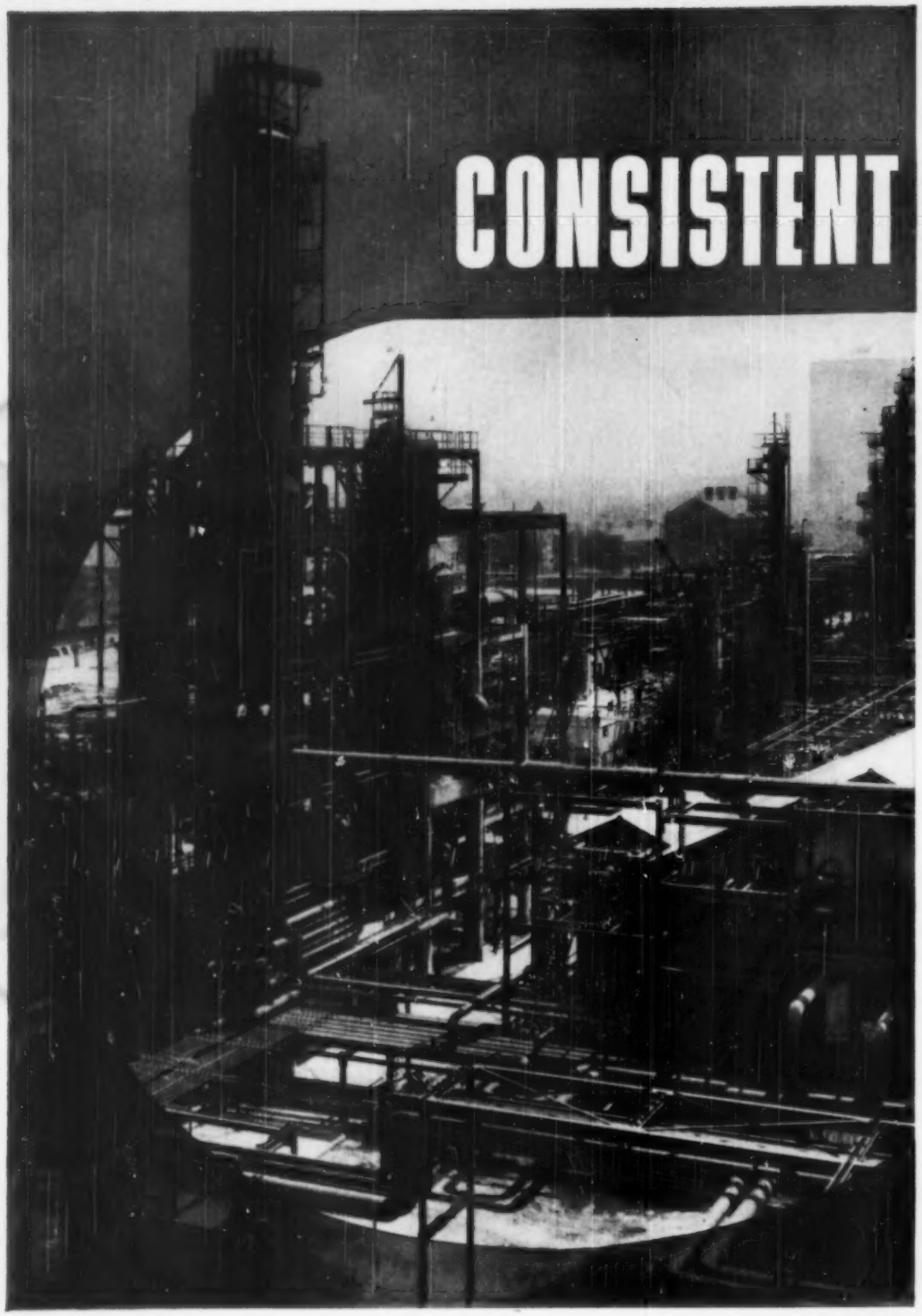
In the complete Worthington line you'll find the *right* speeds and horsepowers to keep your blowers, compressors and other mechanical drives operating at peak efficiency. And since each Worthington Turbine — from the smallest to the largest — is designed to make steam do more work, you can count on steady power- and money-saving throughout a long, trouble-free service life.

Get the whole story of this economical, always dependable power from your nearest Worthington representative. Or for further facts proving *there's more worth in Worthington*, write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

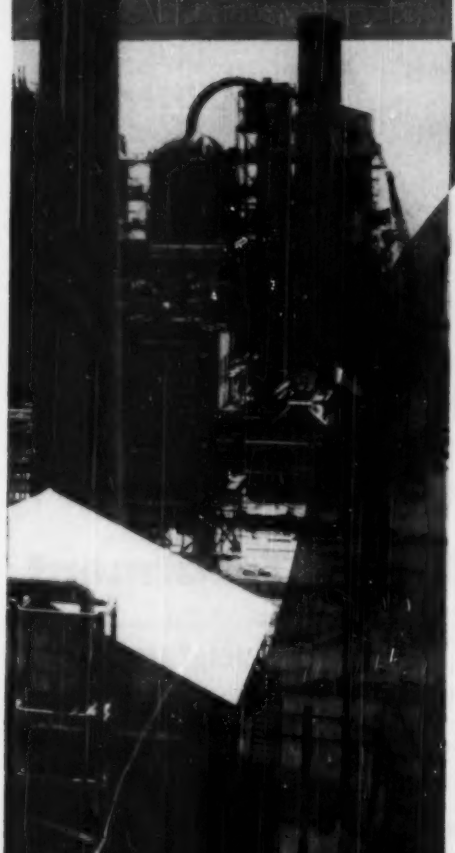
STEAM TURBINES

B9-5


CONSISTENT

PROGRESS

in "The Heart of the Refinery"



This 32,000 barrel combination atmospheric-vacuum topping unit at Gulf Refining Company's Toledo, Ohio, refinery produces light and middle distillates as well as high quality catalytic cracking feed stock from sweet or sour crudes.

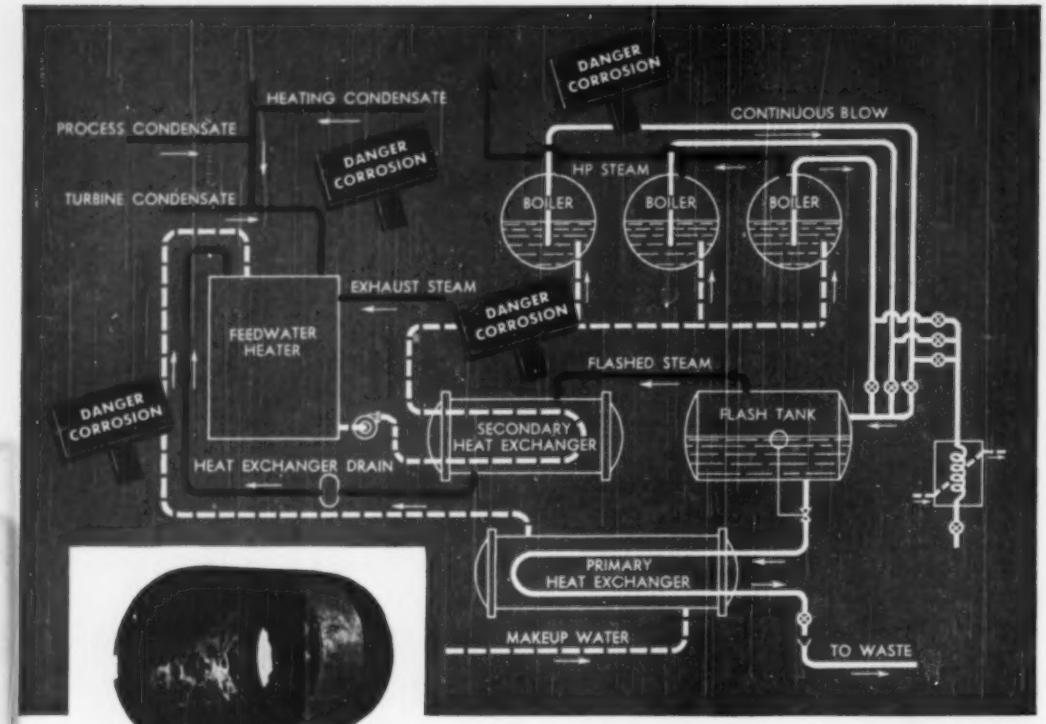
Wartime experience demonstrated the necessity for independent primary distillation facilities to maintain refinery balance when processing varying crudes. Hence this is the fourth two-stage unit which Badger has completed for Gulf's post-war program. All were engineered for wide flexibility in operation and with corrosion protection as determined by the economic balance between installation and maintenance costs.

E. B. BADGER & SONS CO. · Est. 1841

A SUBSIDIARY OF STONE & WEBSTER, INC.

BOSTON 14 · NEW YORK · PARIS · LONDON

Process Engineers and Constructors for the Petroleum, Chemical and Petro-Chemical Industries



AVOID These Danger Signs with BIRD-ARCHER Amine Treatment

CORRODED condensate return lines lead to expensive pipe replacement and maintenance. As an added annoyance, the solid products of corrosion often plug return lines and fill traps. You can steer clear of these troubles by using the *effective, economical* Bird-Archer Amine Treatment.

HERE'S THE WAY THIS B-A TREATMENT WORKS

Amines are fed into the boiler or into the steam and condensate systems. The amines raise the pH value of the condensate and also tend to inhibit equipment-destroying corrosion through surface protection of the metal itself.

HERE'S HOW THIS B-A TREATMENT SAVES MONEY

Raising the pH value of the condensate severely decreases maintenance costs by eliminating corrosion. These savings may more than offset the amount of treatment required to provide protection for your equipment.

NEW BULLETIN gives full details on the Bird-Archer Amine Treatment. . . . contains case histories that prove its successful application in many plants. *Write for your copy today.*

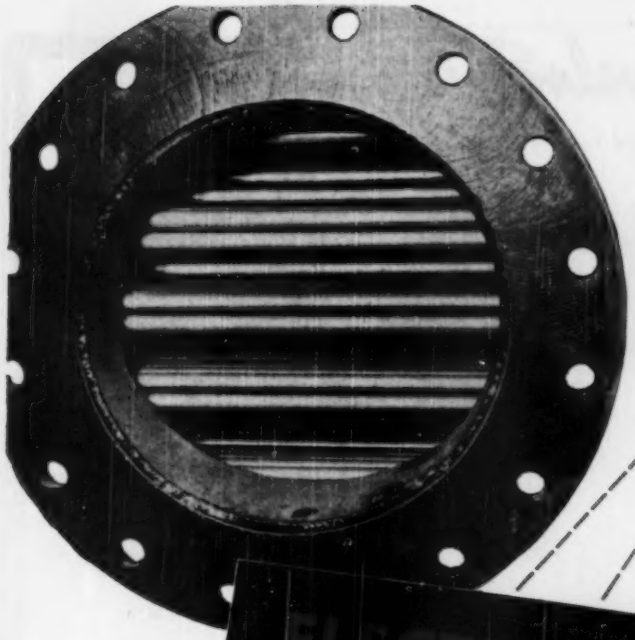
BA-124

WHAT AMINES ARE

Amines are members of a class of chemical compounds in which one or more hydrogen atoms of the ammonia molecule are substituted by an organic group. Some of the simpler types are soluble and volatilize from boiler waters. The alkalinity of the amines is an inherent property and does not result from decomposition. *No free ammonia is released.* In the concentrations necessary for protection of condensate systems, amines are harmless to non-ferrous metals, non-toxic and are completely stable at temperatures approximating 675F.

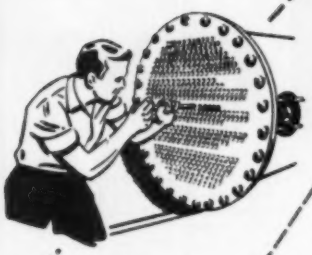
BIRD·ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 400 MADISON AVE., NEW YORK 17, N. Y.
Philadelphia, Pennsylvania • Chicago, Illinois • Montreal, Canada
CALDERAS Y ACCESORIOS, S. A. AMSTERDAM 291, MEXICO, D. F.



New perspective on longer tube life . . . .

ELECTRUNITE Stainless Steel Pressure Tubes



When retubing costs enter the maintenance picture, it's time to consider the multiple advantages of Republic ELECTRUNITE Stainless Steel Tubes for heat exchangers, condensers and evaporators.

Made of long-lasting ENDURO Stainless Steel, these tubes furnish the unsurpassed resistance to heat and corrosion, sanitary properties and other advantages of stainless steel. As manufactured by Republic's improved welding processes, each length is uniformly round and sound, free from surface seams, laps and slivers. *Full annealing* of all ELECTRUNITE Stainless Steel Pressure Tubes assures unvarying high ductility throughout every shipment.

Why not check *today* to determine whether a new perspective on stainless steel pressure tubes might result in profitable cost-savings for your company? *Write, wire or phone* for information specifically related to your operations.

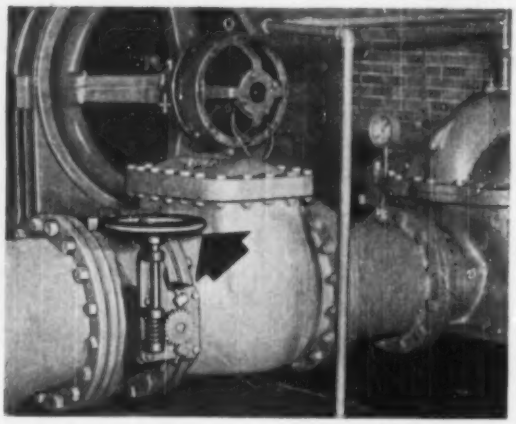
REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Bldg., New York 17, New York

Available in Types
302
304
316
317
347
309-S
310
430
Other Analyses for Special Applications Upon Request

Republic ELECTRUNITE

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



6 HANDWHEEL TURNS OPEN OR CLOSE VALVE

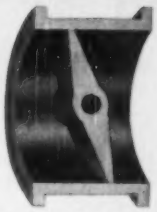
This quick closing feature is an important consideration in water pumping operations as illustrated above or any application where a battery of synchronous driven pumps discharges into a common header.

Normal procedure when starting a pump is to shut off the discharge valve until the pump has gained the desired speed. The valve is then opened gradually. Since it requires only a few seconds of an operator's time, this important operation is not likely to be neglected when R-S Valves are installed. Burned-out motors at start-ups can be practically eliminated.

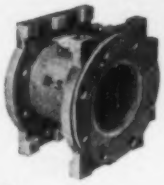
R-S Valves show substantial savings in pumping power due to low pressure drop. Consider also the compact design, light weight and self-cleaning features.

Consult with your local R-S representative. Look for the address and phone number listed under "R-S Products, Valves" or write direct.

R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.



Sectional view shows beveled vane of R-S Valve firmly seated at a 12½° angle. A metal-to-metal seat gives satisfactory commercial shut-off in many cases. Manual or automatic control available.



Drip tight or bubble tight closure can be obtained with a rubber seat. Under pressure, due to the 12½° angle of closure, the rubber yields both radially and longitudinally around the shaft-bosses and the periphery of the valve vane to insure positive shut-off.

No. 709 30-inch 50-pound valve equipped with rubber seat. Air bubble tight at 80 psig and drip tight with water at 100 psig. Fully enclosed gear reduction drive. Every R-S Valve is available in smaller and larger sizes, in all materials and for lower and higher pressures.

New!

Catalog No. 18 featuring R-S 50-pound valves is just off the press. Ask for it!

When the erection of a plant gets underway—most of the gains from efficient construction technique have already been won—or lost! Ultimate savings are largely set in the *planning* of the construction program—as to methods, schedules and labor requirements.

At Lummus, this planning is derived from unsurpassed 'round-the-world experience. Then, it is put into practice by a field staff to whom so-called "unpredictables" are old and familiar.

Sound technique, as Lummus applies it, means a sound night's sleep for those we serve who shoulder the responsibility.

LUMMUS designs and builds with

economy
fulfillment
resourcefulness
teamwork
TECHNIQUE
perspective

TECHNIQUE— in planning

The full effect of detailed planning in advance of actual construction has been realized in foreign work where local facilities are at a minimum. It called for scheduled arrival of tools and materials, periodic estimates of manpower requirements and the preplanning of specific procedures for materials handling and heavy lifts. Economy in requirements for construction facilities, tools and equipment by preplanned re-use at various construction stages is one example. The selection of a supervisory staff with experience permitting effective reassignment as the job progresses is another.

TECHNIQUE— on the job

What makes it possible to move a 150-ton derrick intact from one tower-erection location to another, as contrasted to disassembly and reassembly? Planning—plus practical experience of the field staff on the job! Lummus field personnel has served in some 15 foreign fields, as well as at home, and averages better than 10 years' Lummus experience.

TECHNIQUE— as to costs

From an analysis of unit erection costs in which every man-hour is estimated in advance, Lummus lays the groundwork for continuing cost control. Periodic reports, detailing costs and work-progress, permit evaluation of all phases of the job from start to finish.

THE LUMMUS COMPANY
420 Lexington Avenue, New York 17, N. Y.

LUMMUS

CHICAGO—600 South Michigan Avenue, Chicago 5, Ill.
HOUSTON—Mellie Esperson Bldg., Houston 2, Texas

The Lummus Company, Ltd., 525 Oxford St., London, W-1, England

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Here's what we mean by "Complete Service"

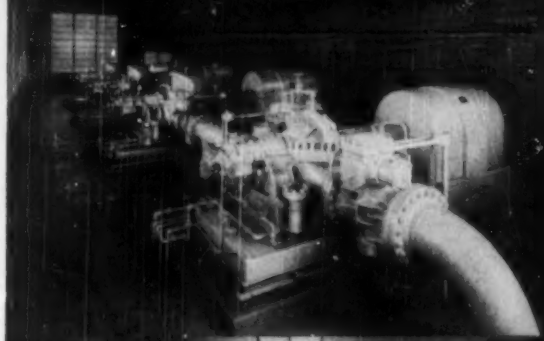
Construction by GRAVER

■ Here's one of the many pipe line pumping stations built *from start to finish* by Graver Construction Co.

Graver constructed the building . . . installed all piping with motor operated valves from the station to the tanks . . . installed all machinery and pumps . . . installed all electrical equipment, switch gears, transformers, and lighting. Graver also put in the macadam roads and sewers . . . built earthen fire walls and leveled the tank yards.

The control room has the latest electrical devices enabling the operator to regulate all valves by push buttons. The room is pressurized to prevent infiltration of vapors.

Make it a point to contact the nearest Graver Construction office and get full details on Graver's *Complete Service*. Get a Graver quotation on your next construction, maintenance, or repair job.



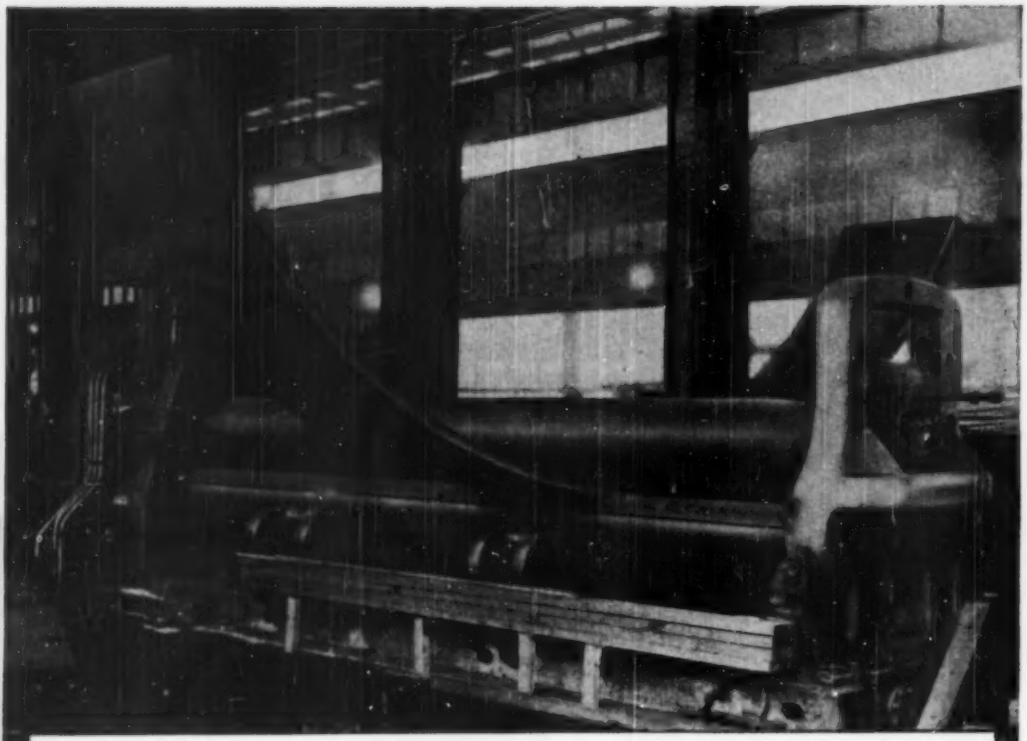
GRAVER CONSTRUCTION CO.

424 Madison Avenue, New York 17, New York

GRAVER

CHICAGO — ENGINEERING DEPT.: 880 BERGEN AVENUE, JERSEY CITY, NEW JERSEY — HOUSTON

A DIVISION OF GRAVER TANK & MFG. CO., INC. EAST CHICAGO, IND.



Equipped to do the job

Sun builds made-to-order units for all refinery and chemical plant processes. Sun also furnishes repair services and parts. This is evidence of the vastness of Sun facilities, facilities that include rolls so powerful as to be capable of cold bending steel sheets 3½" thick . . . Having similarly extensive facilities for shipbuilding, Sun turns out record-making tankers and cargo vessels from keel to superstructure—no subletting.

Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY

"Ready-made" PIPE HANGER for a "made-to-order" FIT

Look how closely this 8-inch steam main is tucked up under the roof. And, at 410 p.s.i. and 550°F., this piping was bound to move up and down enough to need flexible support. Just the hanger to fit this situation was ready and waiting right in the Grinnell Pipe Hanger Catalog 10-D . . . the Pre-Engineered Spring Hanger fig. B268, type G.

Every pipe suspension problem is pre-solved for you by Grinnell ready-to-install hangers and supports. You can get a copy of Catalog 10-D from your Grinnell branch warehouse or local Grinnell jobber.

GRINNELL

Grinnell Company, Inc., Providence 1, R. I. Warehouses: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

New WALWORTH High Pressure LUBRICANT GUN

Save Time—Save Money. With this simple, rugged portable device, it is possible to save in excess of 50% of the time generally required to lubricate Lubricated Plug Valves. It will economically and efficiently handle the stiffest grades of Walworth lubricants.

The gun is self-priming, may be used in any position, and because of its safety features cannot injure the valve.

High pressure button type grease gun fittings—instead of the lubricant screw which is usually furnished—are available for installation on the valve. By painting the valve a distinguishing color to show the service under which the valve operates, and painting the barrel of the gun with the same color, untrained personnel can lubricate valves with the assurance that the correct lubricant has been used.

Walworth has improved and simplified its lubricants so that with a minimum of nine lubricants it is now possible to handle satisfactorily practically all industrial services. The new Walworth 517 and 514 lubricants will take care of 95% of the service conditions encountered in the handling of Petroleum Products and Gas Pipe Lines. The other seven lubricants will take care of most other petroleum, chemical, and industrial services.

All Walworth lubricants are available in Jumbo stick size, individually wrapped and packed 10 sticks per box. Two Jumbo size sticks will completely fill the barrel of the Walworth Lubricant Gun.

for lubricating lubricated plug valves

WALWORTH
valves and fittings
60 EAST 42nd STREET, NEW YORK 17, N. Y.

For best results use Walworth Lubricants in Walworth Lubricated Plug Valves.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Industrial QUALITY

Whether you need gravity storage tanks for a Marine Terminal or pressure and vacuum tanks for a Food Processing plant, the quality standards guiding our operations for more than forty years assure you top quality work.

Highly fabricated tanks and piping as well as simply designed vessels are produced to your complete satisfaction when you utilize the steel experts of our experienced organization.

If you are planning to expand or replace your present storage or materials handling facilities, consider the quality of Southland Steel Products.

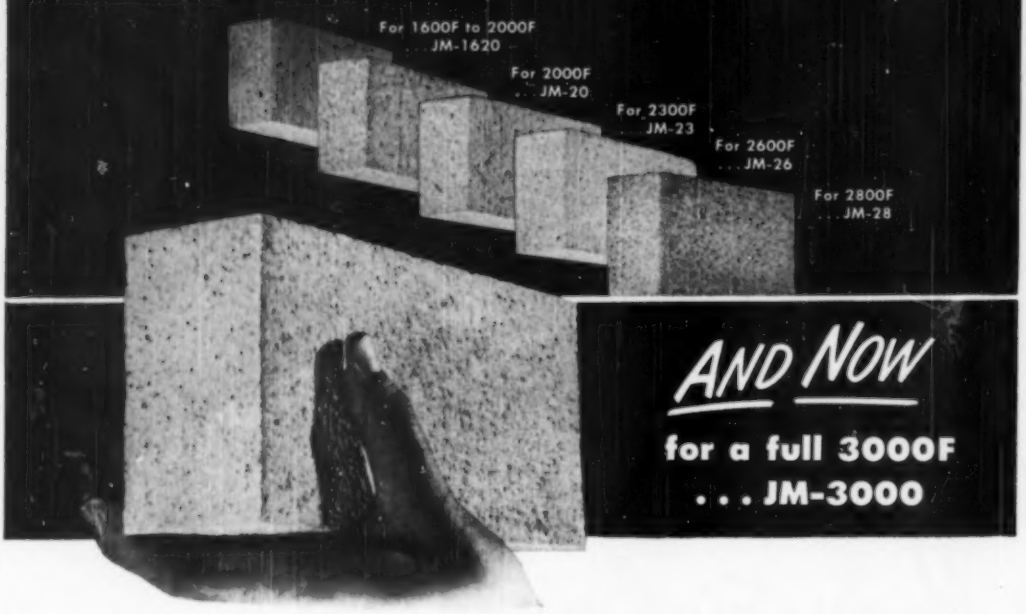
Write us outlining your requirements. Our engineering staff welcomes the opportunity of working with you.

CHATTANOOGA BOILER and TANK CO.

Chattanooga, Tenn.

OVER 40 YEARS OF SERVICE STEEL SOUTHLAND PRODUCTS TO AMERICAN INDUSTRY

MEET the family of Johns-Manville Insulating Fire Brick . .



HERE IS AN OUTSTANDING FAMILY of insulating fire brick for back-up or exposed use . . . the only family of its kind . . . that gives you a complete range . . . a *quick heating* insulating fire brick for every purpose.

By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.32	1.91	2.22	2.50	3.20
1500 F	1.27	1.67	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† 24-hr simulative service panel test for JM-3000; 24-hr soaking period for other brick.

* Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville First in INSULATIONS

COMPLETE "ON-CALL" STOCKS FOR YOUR SPECIALIZED METAL NEEDS

"One-call service... for on-call metals"

Geared to industry's continuous demand for specialized metals, Metal Goods' one-call service is designed to make your metal procurement easier — and more efficient. By having the metals you need "on-call" from your Metal Goods warehouse — when you need them — you can eliminate costly metal inventories... save storage space... reduce materials handling... and gain efficiency through simplifying your supply effort.

Metal Goods warehouses are strategically located to serve you quickly and dependably. Sheets, Plates, Tubes, Bars, Fittings and Accessories of... **STAINLESS STEELS ALUMINUM • BRASS • COPPER • MONEL* • NICKEL* • INCONEL***

Plus... complete stocks of Condenser and Heat Exchanger Tubes... Admiralty... "Alclad" Aluminum... 70/30 Super-Nickel, Monel.

Tube Sheets... Naval Brass... Muntz Metal

Fittings and Accessories

Consult your Metal Goods metallurgical specialist on the proper metal for your application.

**Not warehoused in Kansas City or St. Louis*

Phone, wire or write your Metal Goods warehouse for your specialized metal needs.

Do you have the "Metalog"? It's a complete stock list and metal manual — Write for it!

MGC

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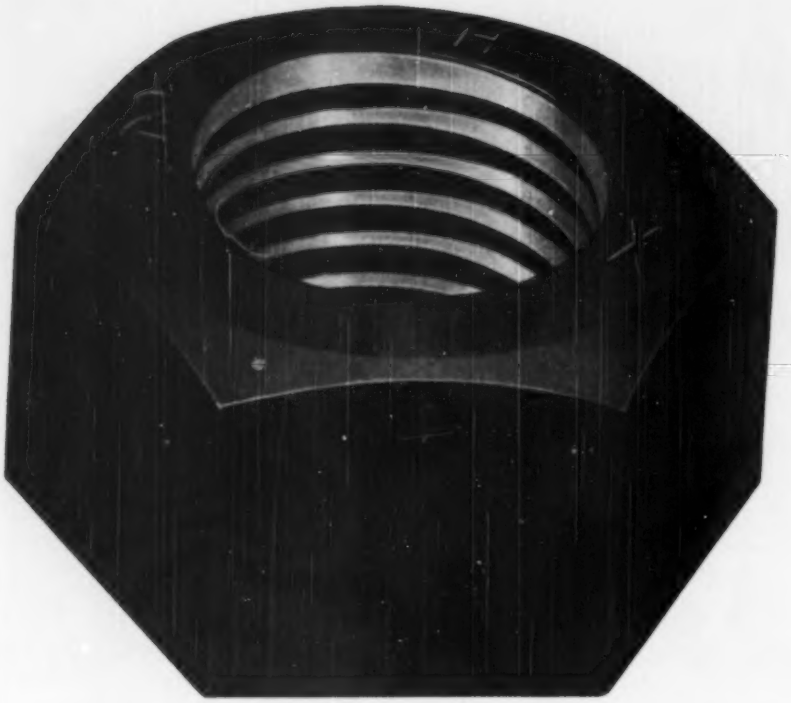


LET IT SHOW YOU

Here's the way to get a true idea of the kind of job the Bethlehem Quenched Nut can do. Choose a high-temperature bolting job—as tough a one as you can find—and put the quenched nut to work.

The Bethlehem Quenched Nut has the internal strength, the stamina, the hardness, and the ductility to absorb all the punishment that high-temperature refinery bolting has to take. This is because it is truly a hot-forged nut. It is not merely punched from a hot bar, but is made by actually forging and extruding hot metal into a forming die. This results in a nut with a highly-refined, tough grain structure—a nut strong enough to break *any* stud or bolt on which it is used.

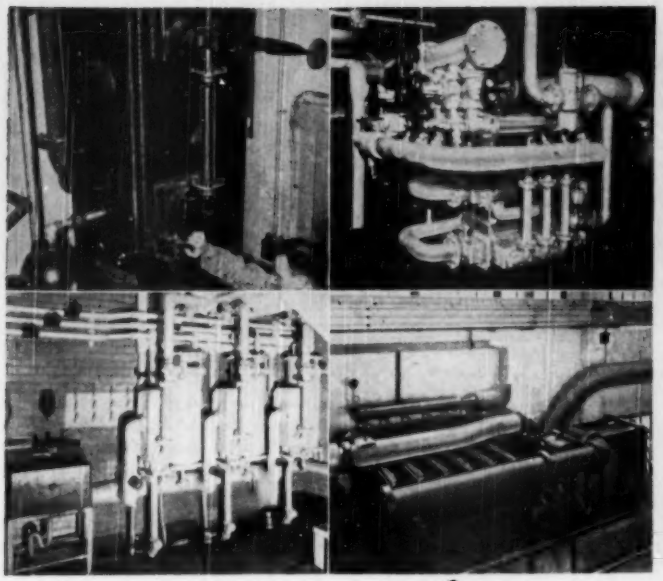
The Bethlehem Quenched Nut has uniform threads. Its oxidized sides are smooth, untrimmed, and resistant to corrosion. Made by Bethlehem's Lebanon, Pa., plant to ASTM Specification A-194, Grade 2H, it comes in all bolt sizes from ⅜ in. to 3½ in. It's ready to show you how good it is, any time you say.

★ BETHLEHEM STEEL ★

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

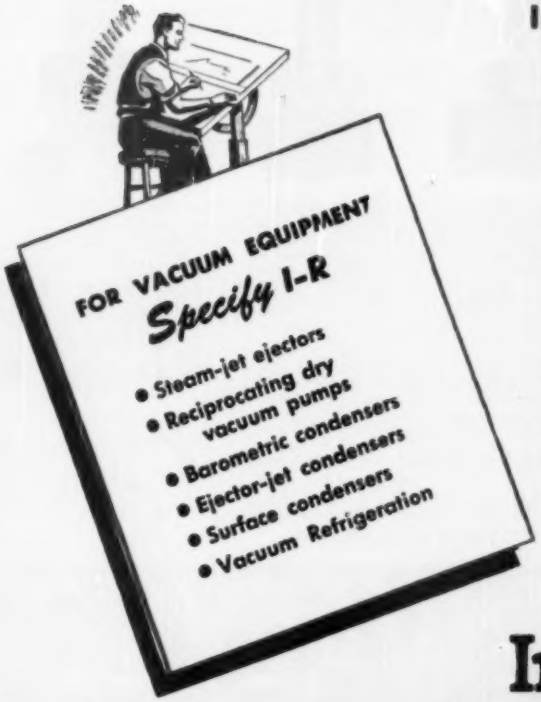
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

Bethlehem supplies every type of Fastening



Vacuum Specialists

Ingersoll-Rand has them . . .



In chemical and food industries where vacuum equipment is an essential part of many highly technical processes, Ingersoll-Rand has the engineering know-how.

You will find trained engineers in Ingersoll-Rand branch offices who are vacuum specialists. They are constantly working with process engineers who are finding new and better ways to make vacuum equipment speed up processing time . . . improve product quality . . . reduce costs.

If you are looking for the answer to a vacuum problem, why not take advantage of the experience of Ingersoll-Rand engineers? They can show you how the correct application of I-R vacuum equipment is producing effective results in chemical and processing plants manufacturing a wide variety of products.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

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You *specify* the service . . . We'll *supply* the RIGHT valve

This may sound like a broad statement, but we can prove it. Because of the completeness of the Powell Line, we are always able to supply the *right* valves to meet the requirements of every industrial flow control service.

You specify the conditions under which the valve must operate. Usually your Powell distributor will know which is the right Powell Valve to meet them. If the conditions present a problem he can always consult Powell Engineers, or if you prefer, write to us direct.

At all events be sure you install the *right* valves—it's easy to do with the Powell Line.* Failure to do so will mean faulty performance instead of the long, trouble-free operation you can expect from the right Powell Valves.

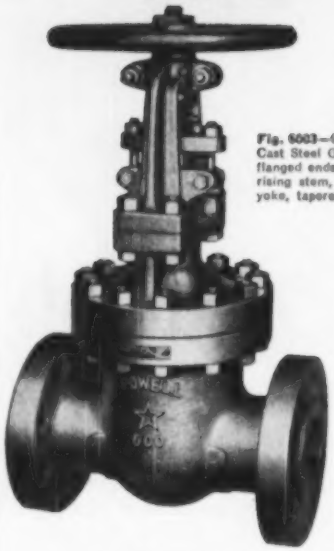

Fig. 6083—Class 600-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, tapered solid wedge.

Fig. 1708—200-pound Bronze Globe Valve with screwed ends, union bonnet, renewable, specially heat treated stainless steel seat and regrindable, renewable, wear-resisting "Powellium nickel-bronze disc.

Fig. 375—200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

Fig. 1793—Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", incl. Has outside screw rising stem, bolted flanged yoke, tapered solid wedge.

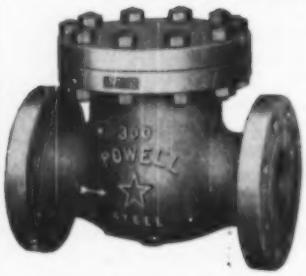

Fig. 3081—Class 300-pound Cast Steel Swing Check Valve with flanged ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

*The Complete Powell Line includes Globe, Angle, Gate, Check, Relief and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-Resisting metals and alloys.

Ask your nearest Distributor—or write direct

The Wm. Powell Co., Cincinnati 22, Ohio

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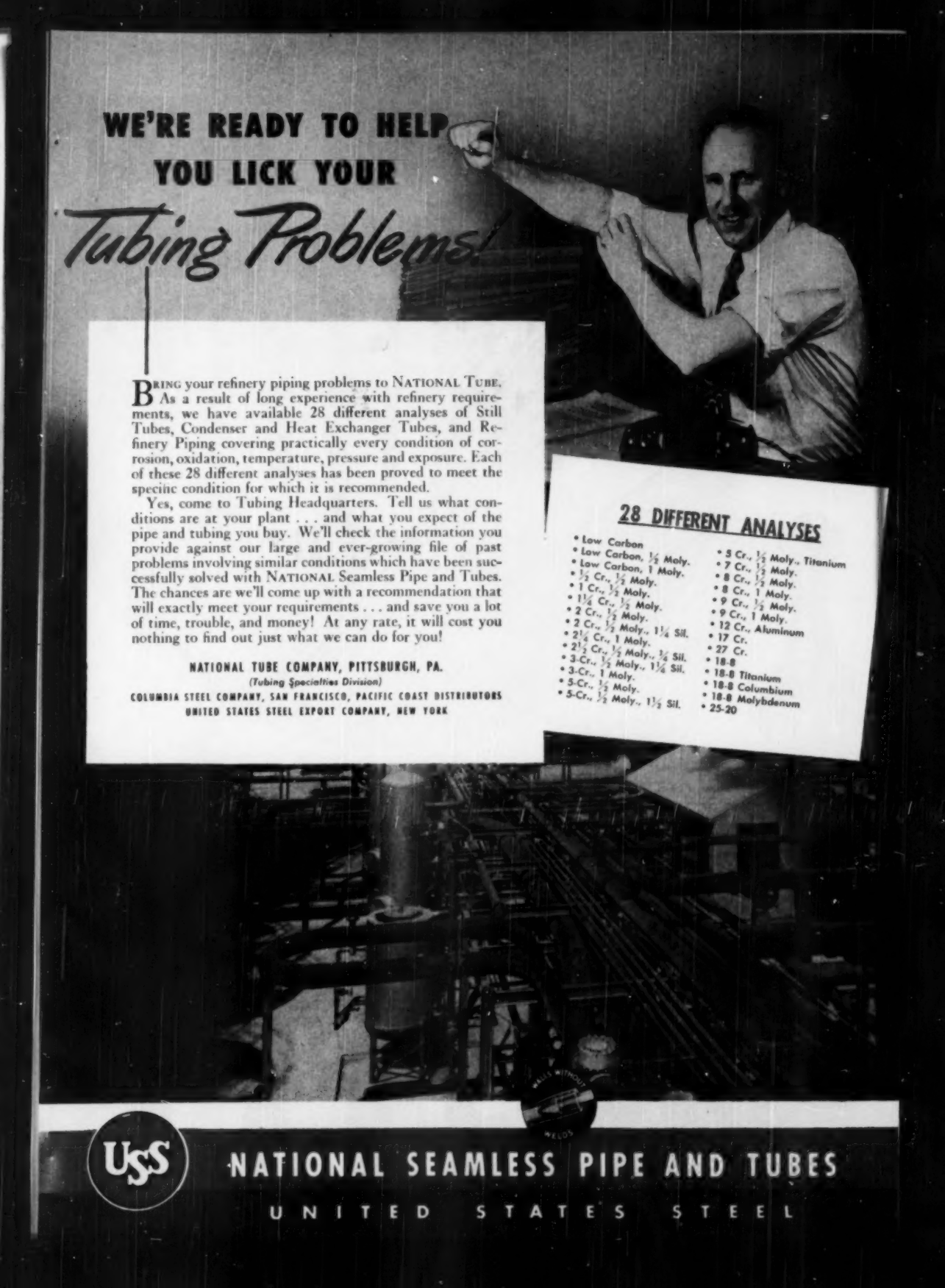
POWELL VALVES



WE'RE READY TO HELP YOU LICK YOUR *Tubing Problems!*

BRING your refinery piping problems to NATIONAL TUBE. As a result of long experience with refinery requirements, we have available 28 different analyses of Still Tubes, Condenser and Heat Exchanger Tubes, and Refinery Piping covering practically every condition of corrosion, oxidation, temperature, pressure and exposure. Each of these 28 different analyses has been proved to meet the specific condition for which it is recommended.

Yes, come to Tubing Headquarters. Tell us what conditions are at your plant . . . and what you expect of the pipe and tubing you buy. We'll check the information you provide against our large and ever-growing file of past problems involving similar conditions which have been successfully solved with NATIONAL Seamless Pipe and Tubes. The chances are we'll come up with a recommendation that will exactly meet your requirements . . . and save you a lot of time, trouble, and money! At any rate, it will cost you nothing to find out just what we can do for you!

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(Tubing Specialties Division)
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

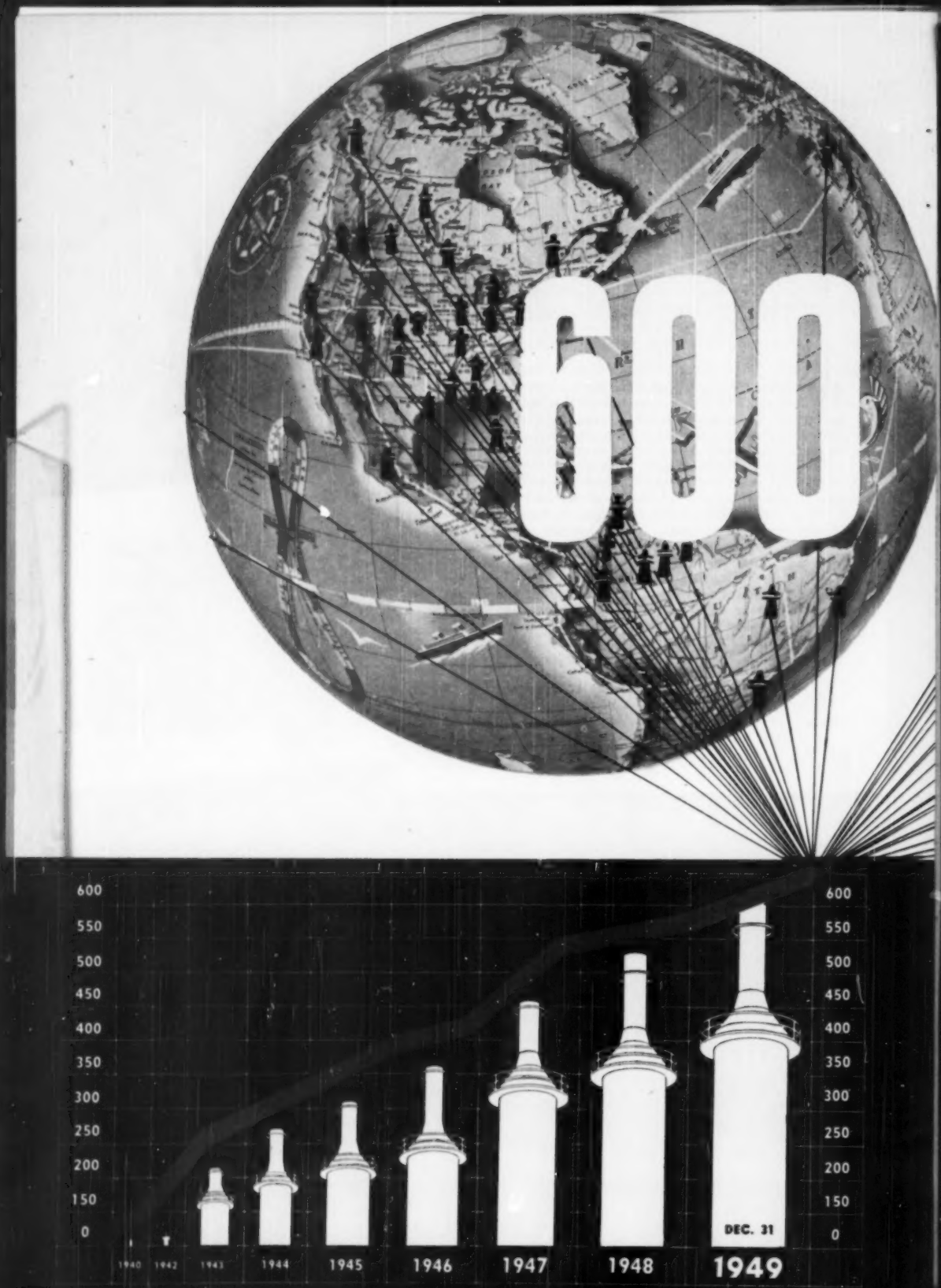
28 DIFFERENT ANALYSES

- Low Carbon
- Low Carbon, ½ Moly.
- Low Carbon, 1 Moly.
- ½ Cr., ½ Moly.
- 1 Cr., ½ Moly.
- 1¼ Cr., ½ Moly.
- 2 Cr., ½ Moly.
- 2 Cr., ½ Moly., 1¼ Sil.
- 2¼ Cr., 1 Moly.
- 2½ Cr., ½ Moly., ¾ Sil.
- 3-Cr., ½ Moly., 1¼ Sil.
- 3-Cr., 1 Moly.
- 5-Cr., ½ Moly.
- 5-Cr., ½ Moly., 1½ Sil.
- 5 Cr., ½ Moly., Titanium
- 7 Cr., ½ Moly.
- 8 Cr., ½ Moly.
- 8 Cr., 1 Moly.
- 9 Cr., ½ Moly.
- 9 Cr., 1 Moly.
- 12 Cr., Aluminum
- 17 Cr.
- 27 Cr.
- 18-8
- 18-8 Titanium
- 18-8 Columbium
- 18-8 Molybdenum
- 25-20

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL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600 PETRO-CHEM
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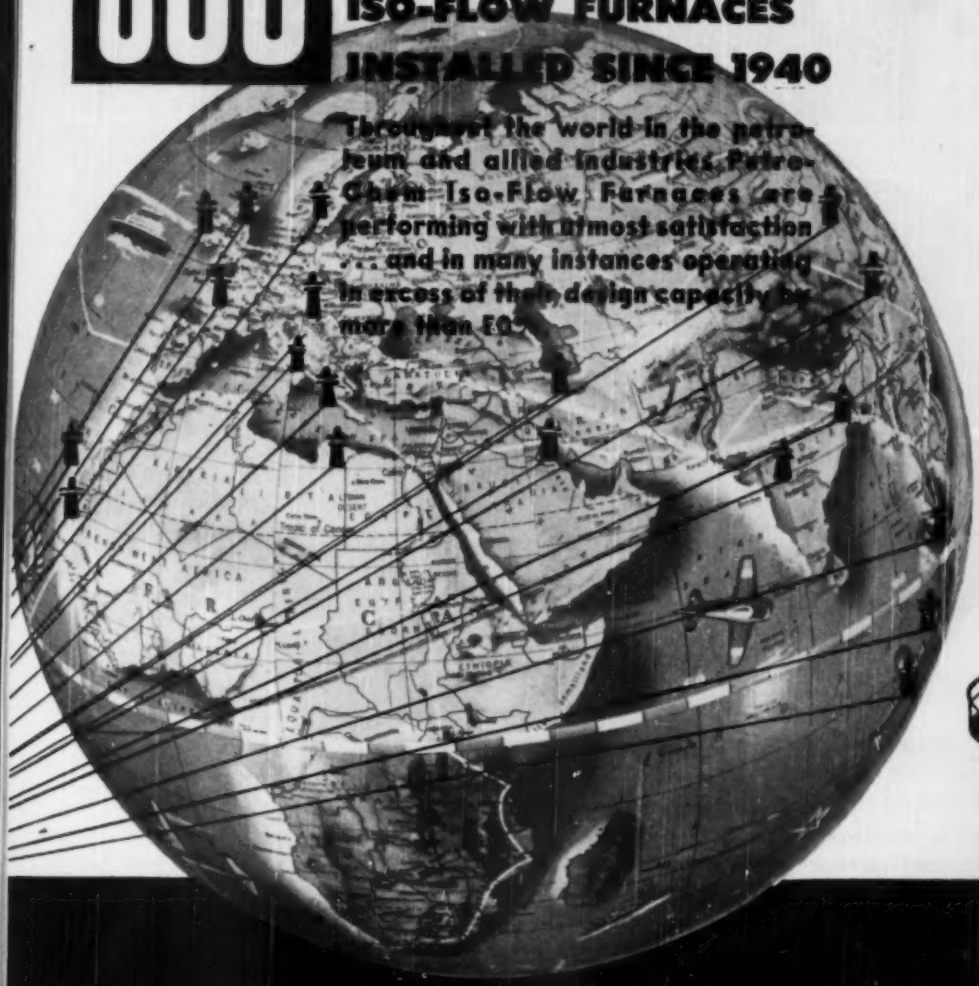

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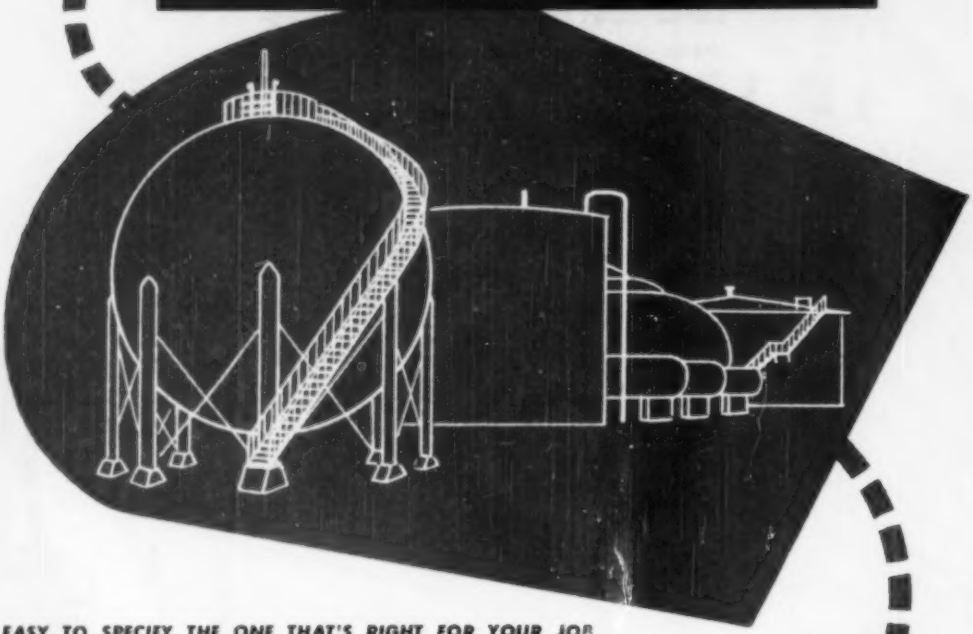
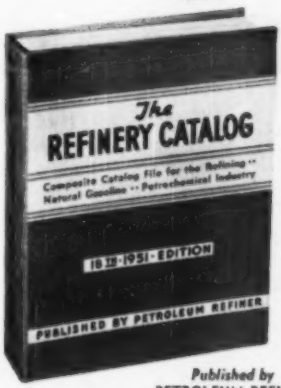
30 TANK MANUFACTURERS HAVE THEIR CATALOGS FILED IN REFINERY CATALOG . . .



IT'S EASY TO SPECIFY THE ONE THAT'S RIGHT FOR YOUR JOB

REFINERY CATALOG furnishes the catalog data you need to compare the leading makes. Besides tanks you'll find complete catalog information on approximately 2,000 other types of process plant equipment and supplies filed between the covers. Three hundred and thirty manufacturers distribute their catalogs in RC to make your buying job easier. When buying or specifying refinery, natural gasoline or petrochemical plant equipment you *save time* and find it quicker by looking it up in The Refinery Catalog.


The
REFINERY CATALOG
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The REFINERY CATALOG

Published by
PETROLEUM REFINER

THE UNIVERSAL EQUIPMENT GUIDE FOR REFINERY BUYERS

...Background for high octane fuels

Today, thanks to the fluid cracking techniques used in modern refining operations, it is possible to produce high octane fuels to match the requirements of engines of high compression ratio. Contributing vitally to this progress has been Cyanamid's development of AEROCAT* Ground and Microspheroidal Synthetic Fluid Cracking Catalysts.

Behind these efficient products, *continually in expanding production to meet increasing requirements,* are Cyanamid's scientifically equipped units, extensive research facilities and the experience and skill of our highly trained technical staffs. *All* of these are at your service to help you select and use the catalyst best suited to your individual needs.

Other Cyanamid specialties for the Petroleum Industry include AEROLUBE* Additives for regular, premium and heavy-duty motor oils . . . AERO** Specialty Catalysts for various chemical processes . . . Gasoline Dyes and Drilling Mud Chemicals. Literature and samples of these products are available on request. Write today.

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PETROLEUM CHEMICALS DEPARTMENT, DIV. A1

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WHEN PERFORMANCE COUNTS . . . CALL ON CYANAMID

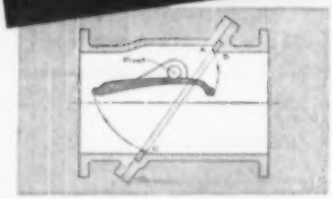
SAVE UP TO 80% IN HEAD LOSSES

with CHAPMAN TILTING-DISC CHECK VALVES

That's right! With Chapman Tilting-Disc Valves, head losses are 65% to 80% lower than for conventional type check valves.

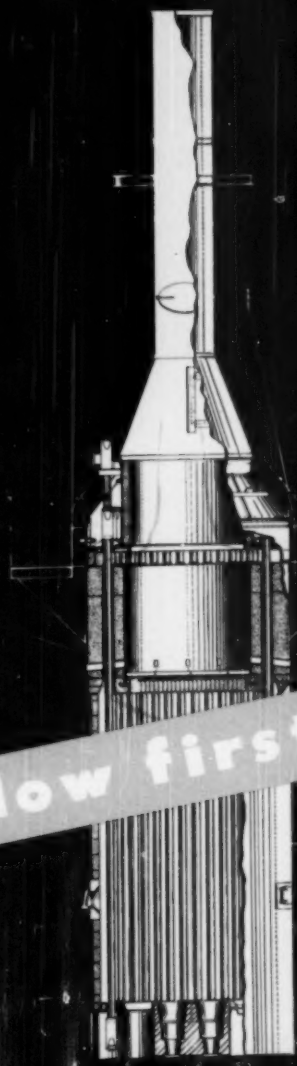
But no wonder head losses are lower. Chapman Check Valves work with . . . not against . . . the stream. The balanced disc rides smoothly on the flow . . . lifts away easily in opening and closes quickly and quietly. There's no slamming to cause destructive pipe line stresses . . . minimum wear on seats, hinge pins and bearings.

All these features mean lower maintenance costs for you. So write *today* for additional information.



Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS



a
simplified
vertical
tubular heater

low first-cost

bare tubes
suspended tubular structure
complete refractory lining
large combustion volume

A "Quickie estimate" of the cost of this heater can be developed for any process heating requirement.

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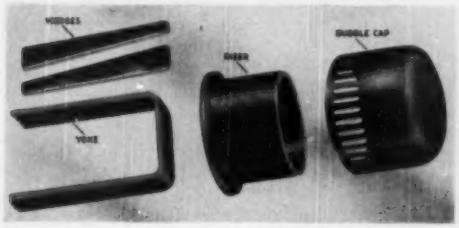
Now YOU CAN

INSTALL OR REMOVE BUBBLE CAPS *FASTER*

the PSC *Way*

Introduced 18 months ago by The Pressed Steel Co., the new LeJons method of assembling bubble caps and risers has substantially shortened the off-stream time required for clean-out and inspection on a "turn around". It has likewise shown impressive savings in tray construction cost.



The above exploded view shows all the parts used in the new LeJons bubble cap assembly. Cap, riser and yoke come securely weld-assembled in one unit, ready for wedging in the tray. To install just hammer in wedges and bend over slightly to lock. To remove, simply knock out wedges. A survey of users shows these seven reasons why this unprecedentedly simple assembly is being increasingly specified:

1) Faster Assembly -- no bolts or nuts.
2) Perfect alignment of caps automatically.
3) Tighter Assembly -- unit locked positively.
4) Stronger Trays, due to wedging action.
5) Eliminates costly flaring or welding of risers.
6) Less Maintenance, due to simplicity and tightness.
7) Ease of Cleanout or Replacement.

Assemblies furnished in any workable metal, style and size of cap. Gages of metal in cap and riser to suit size. Made to suit tray plate thickness with or without gaskets. Yoke of 1/8" metal. Wedges of 12 and 14 gage.

OVER 150 STANDARD STYLES *of bubble caps are furnished* WITHOUT DIE COST

All of the over 150 standard PSC bubble caps are furnished for tray assembly by the LeJons or any other standard method. With dies on hand for this wide choice of styles, The Pressed Steel Co. not only makes prompt delivery, but we save many customers the cost of dies. Send your blueprints. Special caps promptly designed. Let our technical staff aid you. BULLETINS 21 and 31 on request.

LICENSED UNDER PATENT NO. 2480562

THE PRESSED STEEL COMPANY

of WILKES-BARRE, PENNSYLVANIA

Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

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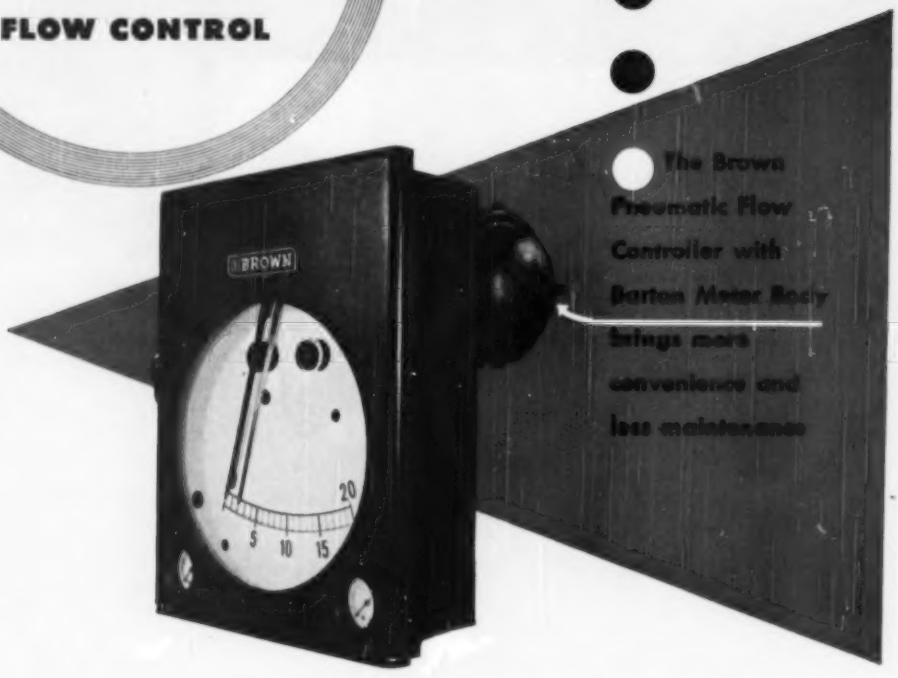
AN IMPORTANT ADVANCEMENT IN PNEUMATIC FLOW CONTROL



The Brown Pneumatic Flow Controller with Barton Meter Body brings more convenience and less maintenance

COMMERCIAL • RESIDENTIAL • INDUSTRIAL
WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL

Here's flow control flexibility . . . one instrument for any application, regardless of flowing medium. The absence of mercury avoids process contamination . . . the Stainless Steel bellows are non-corrosive. In addition, installation is simplified and piping problems are minimized.

The Brown Pneumatic Flow Controller with Barton Meter Body makes an ideal combination . . . adds a new degree of freedom to control of flow and utilization of pneumatic transmission.

Call in your local Honeywell engineer for a discussion of your applications . . . he is as near as your phone!

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BROWN INSTRUMENTS DIVISION
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Offices in 73 principal cities of the United States, Canada and throughout the world

Honeywell — *Advanced Instrumentation* FOR THE PETROLEUM INDUSTRY — BROWN

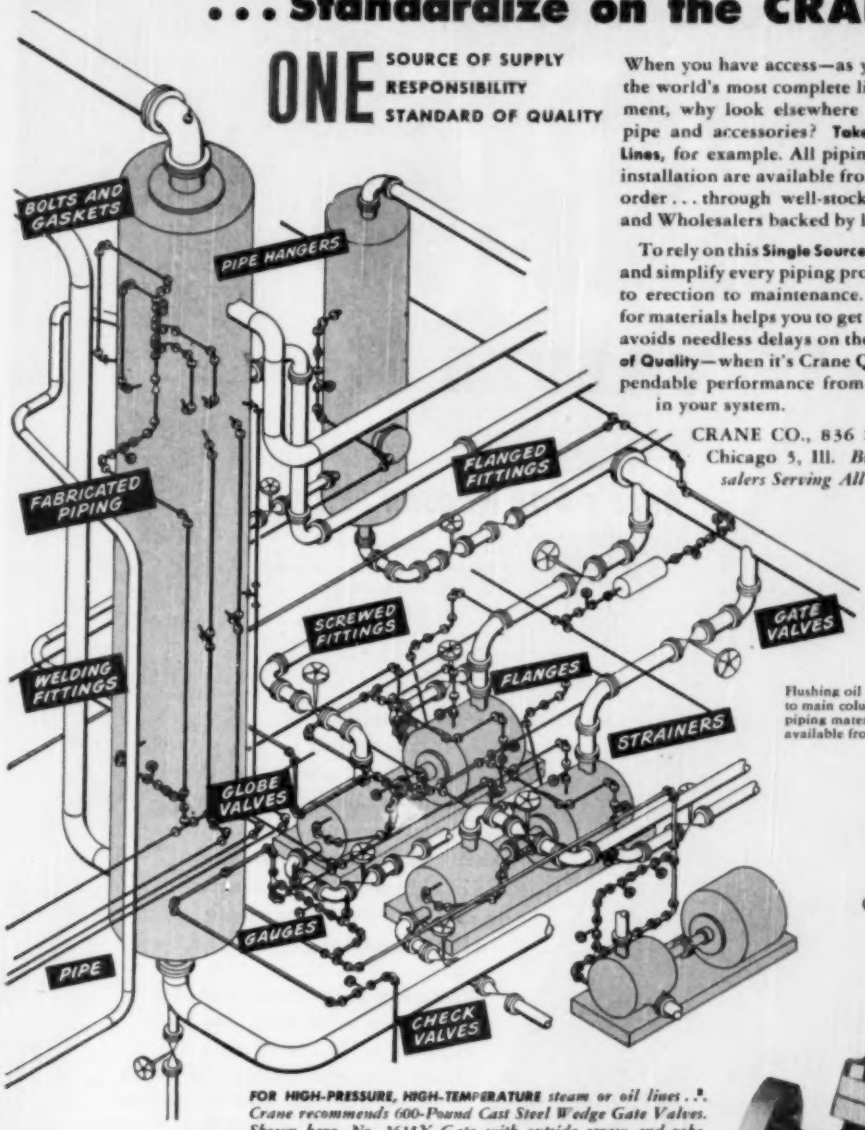
How to simplify piping jobs ... Standardize on the CRANE line

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

When you have access—as you do at Crane—to the world's most complete line of piping equipment, why look elsewhere for valves, fittings, pipe and accessories? **Take these Flushing Oil Lines,** for example. All piping materials for the installation are available from Crane . . . on one order . . . through well-stocked, local Branches and Wholesalers backed by large factory stocks.

To rely on this **Single Source of Supply** is to speed and simplify every piping procedure from design to erection to maintenance. **One Responsibility** for materials helps you to get better installations, avoids needless delays on the job. **One Standard of Quality**—when it's Crane Quality—assures dependable performance from every piping item in your system.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill. *Branches and Wholesalers Serving All Industrial Areas.*



Flushing oil lines to main column—all piping materials available from Crane.

FOR HIGH-PRESSURE, HIGH-TEMPERATURE *steam or oil lines . . . Crane recommends 600-Pound Cast Steel Wedge Gate Valves. Shown here, No. 3615X Gate with outside screw and yoke. Exelloy to Exelloy seating makes these valves ideal for oil and oil vapor services up to 1000 deg. F. Flanged, screwed, or socket-welding ends. Sizes: ½ to 2 in. See your Crane Catalog.*

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VALVES • FITTINGS
PIPE • PLUMBING
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FOR EVERY PIPING SYSTEM

more and better service
from
R·P&C
VALVES

...here's One Reason Why:

Over 60 years ago,
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passed this resolution:

Resolved:

"That the superintendent
"shall be held responsible
"for the production of goods
"as near perfect in design,
"material and workmanship
"as shall make them merchantable
"and of a character that will serve
"to establish for this company
"a high reputation."

•This policy has remained unshaken through two world wars. The "high reputation" has been maintained. More than ever before, the valves offered by R-P&C meet the demand for longer and better service.

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R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

READING-
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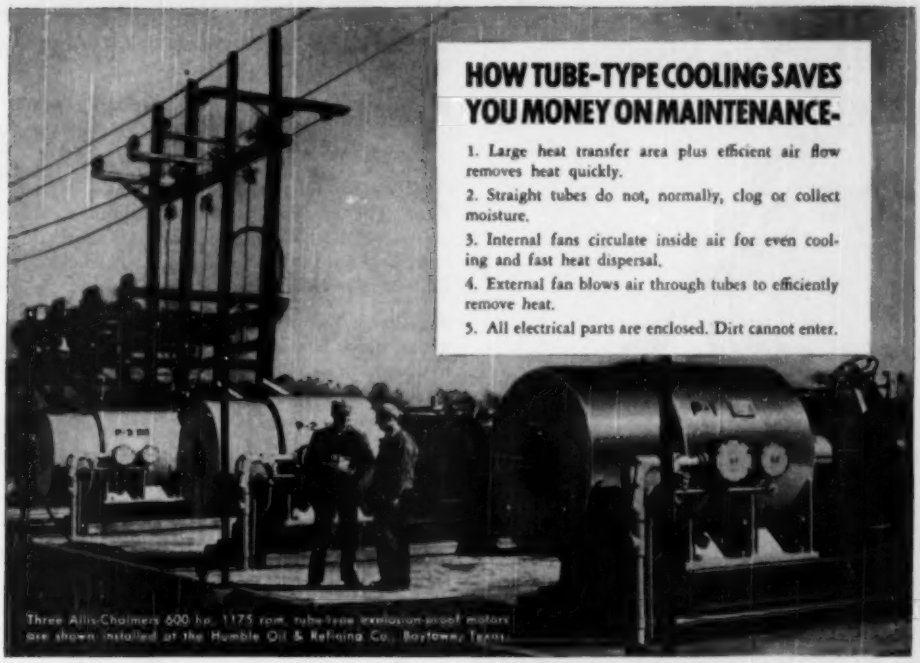
New A-C Tube-Type Motors Used By 18 Leading Petroleum Companies!


HOW TUBE-TYPE COOLING SAVES YOU MONEY ON MAINTENANCE-
1. Large heat transfer area plus efficient air flow removes heat quickly.
2. Straight tubes do not, normally, clog or collect moisture.
3. Internal fans circulate inside air for even cooling and fast heat dispersal.
4. External fan blows air through tubes to efficiently remove heat.
5. All electrical parts are enclosed. Dirt cannot enter.
Three Allis-Chalmers 600 hp, 1175 rpm, tube-type explosion-proof motors are shown installed at the Humble Oil & Refining Co., Baytown, Texas.

OVER ONE THIRD of Allis-Chalmers tube-type, explosion-proof motors have been purchased by 18 of the world's leading petroleum companies! . . . Proof that petroleum operators want these important features:

1. APPROVED BY UNDERWRITERS' LABORATORIES for ratings to *450 hp at 3600 rpm.* Motors of similar design are offered in larger sizes. This new, tube-type motor is the simplest explosion-proof design now offered in the very large sizes.

2. MOTOR IS SELF-CLEANING because of straight flow of cooling air — avoiding hidden recesses encountered in usual designs. If unusual operating conditions make cleaning desirable, motors can be cleaned while in operation — simple as cleaning your shotgun with a ramrod!

3. QUIET OPERATION because of improved fan design . . . straight flow of cooling air . . . smaller quantity of cooling air required by effective radiation system.

4. LIGHTER WEIGHT, YET MORE EFFICIENT! Elimination of heavy shell castings reduces motor weight . . . no sacrifice of electrical performance.

You'll want more information on how this *new* motor can help save maintenance dollars! Send for Bulletin 51R7149.

ALLIS-CHALMERS, 1062A SO. 70 ST.
MILWAUKEE, WIS.

Texrope is an Allis-Chalmers trademark.

ALLIS-CHALMERS

A-2788

NO "FREEZE-UP"

with YARWAY TRAPS

Troubled with outdoor steam traps freezing? Solve the problem the way Thermoid did at their Trenton, N. J., plant.

They installed Yarway Impulse Steam Traps on coal handling equipment. Now, though temperatures dip to zero and snows pile high, their traps never freeze.

Condensate does not accumulate in Yarway Impulse Traps. The only moving part—a little valve—floats on the load. It discharges condensate as it comes through, instead of waiting for a quantity to accumulate. Hence —nothing to freeze.

Add to that, Yarway Traps' reputation for low maintenance, quick heating, easy installation, and economy of operation and you have reasons why over 600,000 Yarways have already been bought.

Often it costs less to install new Yarways than to repair old type traps. See your nearest Mill Supply Dealer. For his name, and free Yarway Trap Book, write . . .

YARNALL-WARING COMPANY
128 Mermaid Avenue, Philadelphia 18, Pa.
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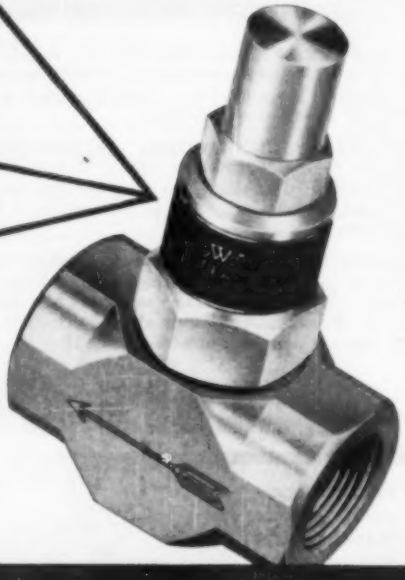
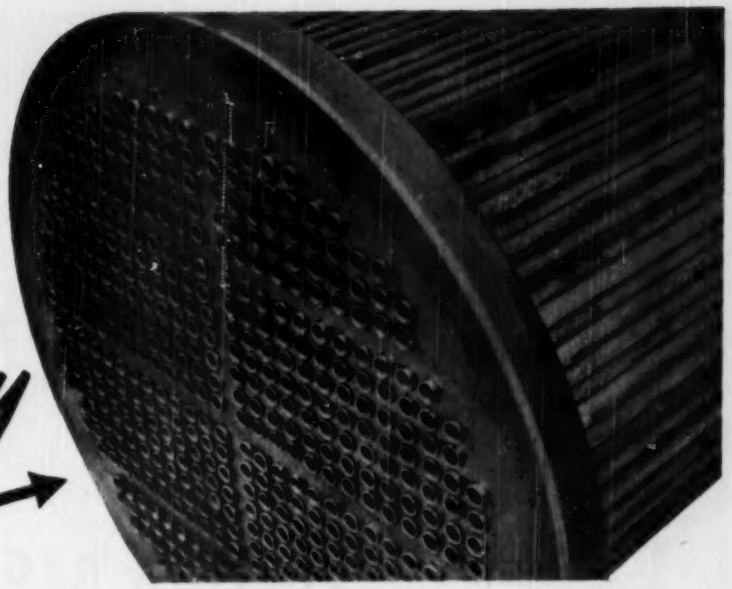
Yarway Traps beat the worst weather in this installation at Thermoid's Trenton plant.



YARWAY **IMPULSE STEAM TRAP**

For economy here →



MONEL-CLAD STEEL TUBE SHEETS CAN BE RE-USED

The Monel® cladding guards against corrosion.

The steel base permits *re-rolling*...no need to scrap Monel-Clad tube sheets when re-tubing.

You get *solid metal* advantages with clad steel economy.

Where circulated liquid is brine or otherwise corrosive, Monel-Clad tube sheets can be expected to give exceptional service... even when other metals have proved unsatisfactory.

Because of its high corrosion-resistance and its long life economy, Monel-Clad Steel has found wide acceptance in the petroleum and chemical industries where adverse conditions are a threat to operating equipment.

Lukens Monel-Clad Steel for tube sheets meets the standards of the Tubular Exchanger Manufacturers Association. A uniform, ⅜ in. thickness of Monel is permanently bonded to ASTM A-212 Grade B backing. Cladding of this thickness will accommodate the pass partition grooves and first hole tube groove.

For your convenience, Lukens Monel-Clad Steel for tube sheets is stocked in ready-to-use standard plates. Thicknesses now available range from 2 in. to 4 in., in ½ in. increments.

For further information and prices on Lukens Monel-Clad Steel, write directly to the Lukens Steel Company, 524 Lukens Building, Coatesville, Penn.

And for the tough jobs, Monel condenser tubing is available from stock in ¾" diameter and wall thicknesses of 14 and 16 gauge. For sources of supply, write directly to Inco.

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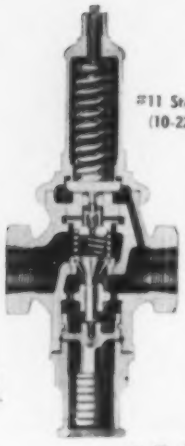
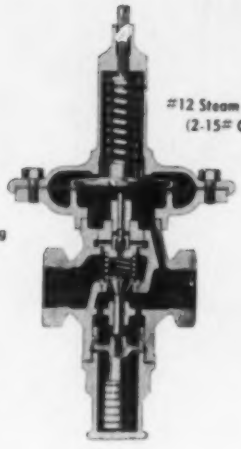
MONEL... for minimum maintenance

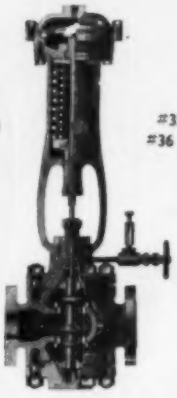
EMBLEM OF SERVICE INCO



#11 Steam Reducing
(10-225# Outlet)

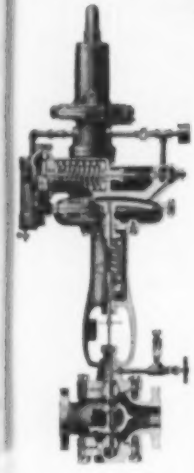


#12 Steam Reducing
(2-15# Outlet)



#35 Reducing
#36 Back Press.

#27 Reducing
#47 Back Press.



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Wire or Telephone "MAINTENANCE" about your Pressure Control Problems

Our application engineers will understand your needs and recommend most suitable regulator for the job.

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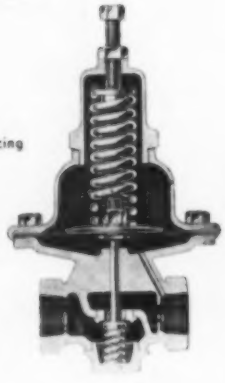
Regulators
Liquid Level Controllers
Diaphragm Control Valves

from LARGE HOUSTON STOCKS



#33 Reducing

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EQUIPMENT WITH ENGINEERING SERVICE

MECO

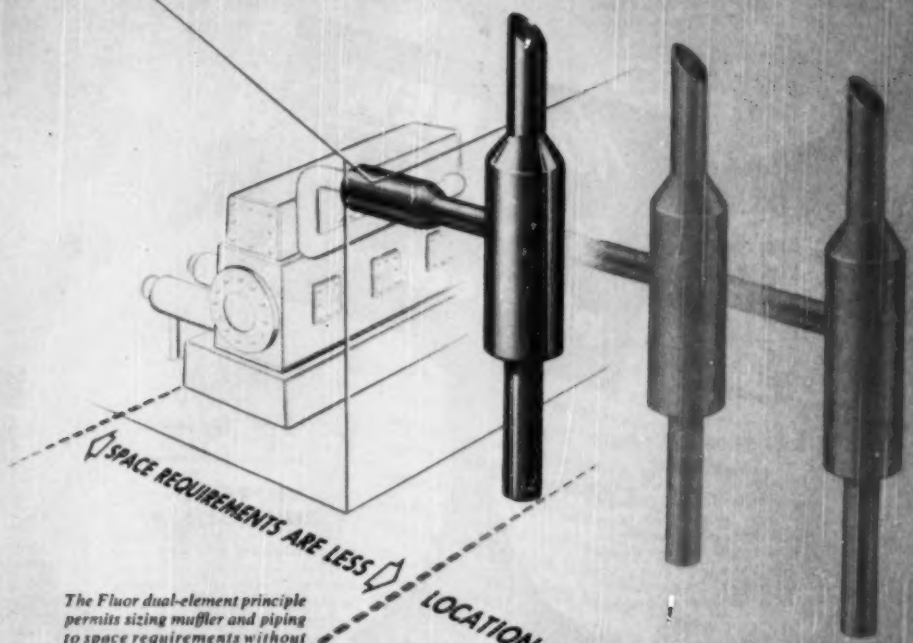
See for yourself...

the installation advantages of a FLUOR SERIES "D" MUFFLER SYSTEM

NO LONGER is ultimate muffling efficiency dependent upon trial-and-error locating of exhaust piping. With the Fluor Series "D," exhaust piping can be of *smaller* diameter, location of outside exhaust chamber *flexible* without affecting pressure drop or noise attenuation and pulsation reduction efficiency.

The reason lies in the unique dual-element design of this muffler *system*. Work is started on pulsative exhaust gases *at* the engine—noise and pulsation reflections are virtually eliminated *at* their source. The Fluor Series "D" Muffler is a *system* that incorporates *two* muffling elements—a primary element located in the immediate proximity of the engine and a secondary element located *at any desired spot* outside the engine room.

The Fluor Series "D" Muffler System is the answer to your muffling problems. In addition to installation flexibility it provides the highest muffling efficiency obtainable—*at a cost competitive with conventional mufflers.*



The Fluor dual-element principle permits sizing muffler and piping to space requirements without setting up hazards common to single-element mufflers.

All elements, including interconnecting piping, are engineered to a minimum in diameter.

Because muffling is spread throughout a Fluor Series "D" System, the outside muffling chamber can be set at any desired distance from the engine room wall.

AVAILABLE FROM STOCK—A Fluor Series "D" Muffler System to fit virtually any 2- or 4-cycle, 200 to 2400 HP diesel engine is available from stock. You need only submit engine room design and dimensions, make, model and RPM of engine and whether muffling system is to be air-cooled or non-air-cooled. Inquiries will be answered promptly.

THE FLUOR CORPORATION, LTD.

FLUOR

BE SURE WITH FLUOR

MANUFACTURERS of Mufflers, Pulsation Dampeners, Gas Cleaners, Cooling Towers and Fin-Fan Units.

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Represented in the Sterling Area by:
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VIRTUALLY UNBREAKABLE!
So strong that the pH-sensitive bulb can withstand as much pressure as the thick stem itself!
Abrasion resistant—unusually rugged for long life and reliable measurement even in highly abrasive slurries!
Chemical durability—excellent in the strongest acids and alkalis . . . even at elevated temperatures!
COVER EXTREME TEMPERATURES!
30° to 130° C at high pH—with the new high temperature—high pH glass.
—20° to 100° C—with the new general-purpose glass. Will withstand even repeated freezing.
Now- NEW BECKMAN pH Electrodes
UNPRECEDENTED pH RANGE!
0 to 14 pH—with the high-temperature high-pH glass . . . only small reproducible deviation near extreme limits, even at high temperatures.
0 to 11 pH—at room temperature and 0 to 10 pH at boiling for the general-purpose glass . . . without correction for sodium ions!
IMPROVED CONSTRUCTION!
Simplified, heat-resistant construction eliminates wax filling . . . retains patented Beckman internal shielding . . . increases measurement precision.

Only *Beckman Glass Electrodes* offer all of these features:

- **RAPID RESPONSE** . . . accuracy with speed and convenience.
- **STABILITY** . . . to match the high precision of BECKMAN pH METERS.
- **INTERNAL SHIELDING** . . . gives complete freedom from outside electrostatic interference.
- **INTEGRAL LEADS** . . . Continuous insulation into the electrode . . . connections located on protected panel board.
- **EXTREME TEMPERATURE RANGE** . . . Several types permit use from below freezing to boiling *and above!*
- **ENTIRE pH SCALE** . . . *Very small* sodium ion errors . . . e.g., with high-temperature high-pH glass, only 0.2 pH deviation at 13.7 pH in 1 N sodium hydroxide.
- **FACTORY SEALED** . . . rigidly tested . . . no maintenance.
- **UNIQUE CHEMICAL DURABILITY** . . . in alkali . . . in acid . . . in dilute solutions.

And . . . *REALLY TOUGH* . . . can even be used as a stirring rod!

These new electrode glasses are now being used in several Beckman electrode styles. As rapidly as possible, they will be available in the full line of Beckman Glass Electrodes.

Constant Research over the years has maintained Beckman Leadership in the instrumentation field . . .
—Beckman *pH Meters and Glass Electrodes*
—Beckman *Ultraviolet, Visible and Infrared Spectrophotometers*
—Beckman *Radioactivity Meters and Special Instruments . . . Unsurpassed for Reliability!*

BECKMAN INSTRUMENTS
control modern industries

BECKMAN INSTRUMENTS • National Technical Laboratories, South Pasadena 25, California

EFFICIENCY Starts at the Top

Instant break-up of water flow is an important step toward cooling tower efficiency. Exact centering of water orifices over the top layer of wood fill, as illustrated, is the C. H. Wheeler method of water dispersion where it counts most, since smaller particles of water are immediately subjected to maximum air flow....Lasting and rugged construction throughout as exemplified here by unusually sturdy wood fill and distribution flumes, enables C. H. Wheeler to guarantee cooling towers to withstand hurricane wind velocities. Ask for descriptive bulletin or quotation.

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STEAM CONDENSERS · AIR EJECTORS
COOLING TOWERS · HEAT EXCHANGERS
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In Refineries, FLEXIBILITY COUNTS

GET POWER WITH

In oil refineries, where modernization programs frequently require shifting of equipment from place to place within the plant, drives with flexibility of application are a "must". This is one more reason why General Electric's STANDARD line of mechanical-drive turbines is winning such popularity in the petroleum industry. They can be easily transferred from one job to another, their speed and range changed easily, and their horsepower rating adjusted economically.

DP TURBINES PROVIDE FLEXIBILITY *THREE* WAYS

1. EASY TO RE-LOCATE

Shaft height is the same on all G-E standard single-stage turbines. This means that moving turbines from one job to another doesn't require a "custom line-up job." Not only shaft height, but size of coupling fit and keyways are standard on every unit.

DP turbines are quickly aligned, too. Unless casing temperatures are high, DP's can be lined up cold with the assurance that shaft lift will be within allowable limits when the turbines are heated. Such easy alignment is possible only on a center-line supported unit.

2. EASY TO ADJUST SPEED

By adjusting a simple handwheel, the speed setting can be varied within a 30% range. Once adjusted, the DP's hydraulic governor holds speed accurately.

If a change in application makes a new speed range necessary, the range can be set anywhere from 800 to 5000 rpm by simply substituting a new emergency governor and a new set of low-cost gears on the governor drive. These gears are standard, available on immediate delivery from the factory.

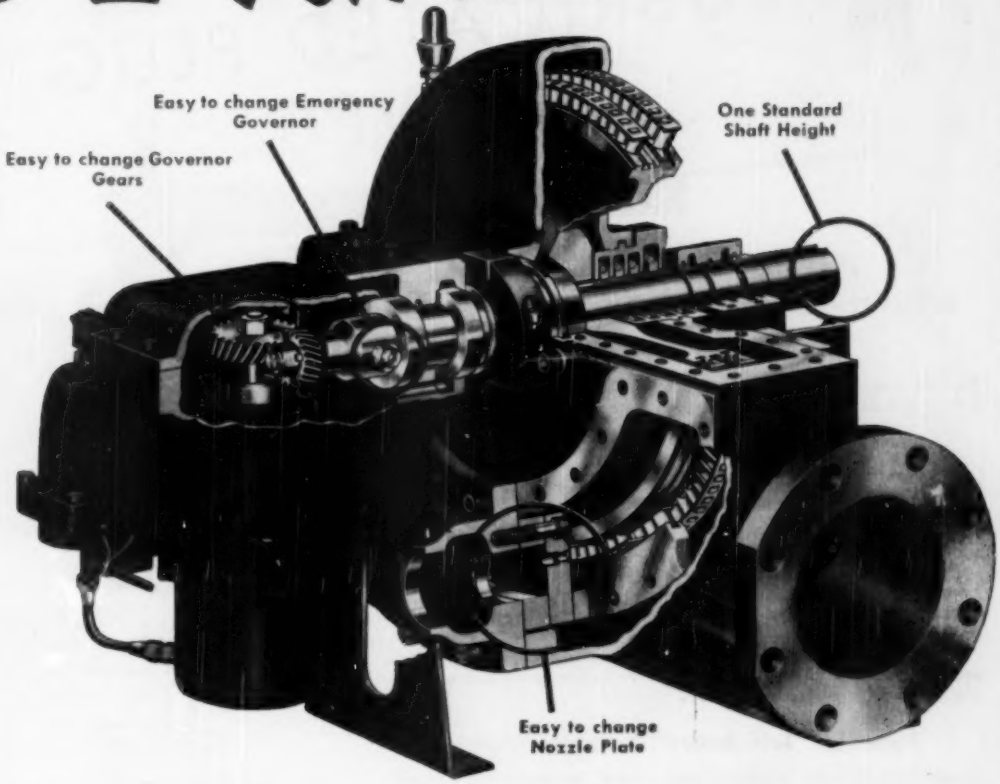
3. EASY TO CHANGE RATING

When steam conditions or load demands change, a DP turbine can be adapted at a reasonable cost for the new requirements if they are within the steam flow capacity of the casing. Example: If it is desired to increase the horsepower rating, the only changes which are usually necessary are new nozzle plate and valve parts. The cost of such parts is far less than the cost of a new turbine—which would be required with a less flexible unit.

REMEMBER...

"DP means Dependable Power"

FLEXIBILITY G-E TURBINES



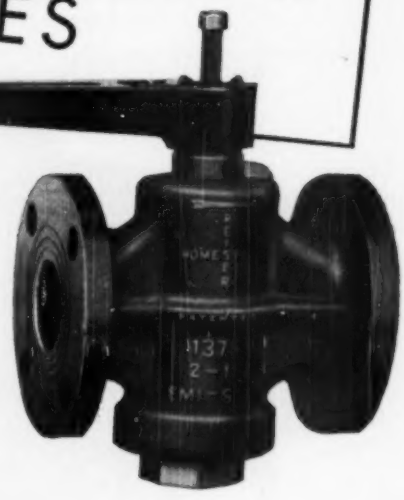
The General Electric standard DP Turbine incorporates many outstanding features previously found only on "special" turbines. They give you a drive which is dependable and flexible—ideal for application in the oil industry.

For the full story on how these features can mean operating benefits for you, call your G-E representative. Or write today for GEA-4955, a 20-page, descriptive bulletin. Apparatus Dept., General Electric Co., Schenectady 5, N. Y.

GENERAL ELECTRIC

You can't buy A LOWER COST-PER-YEAR VALVE than

HOMESTEAD-REISER *Self-Sealed* LUBRICATED PLUG VALVES



They are the lowest-priced, full-port-area plug valves in their pressure and temperature range

And they *outlast* all other lubricated plug valves in their class. Every one of their many outstanding advantages including

100% area of standard pipe
100% lubricant seal around ports
Extreme economy of lubricant
Single lubricant for wide variety of applications, and
Self-sealing automatic adjustment for wear

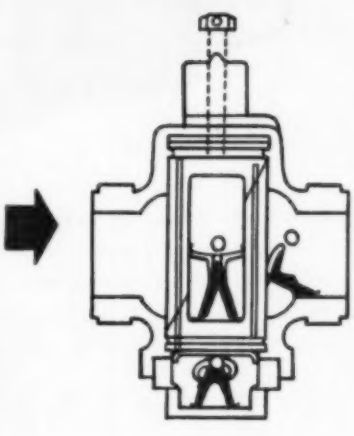
. . . are features asked for by engineers and operating men of industry.

Proof of their long, economical, dependable performance has been established in practically every industry during the past seven years. And at their new low price, they are more than ever your lowest cost-per-year fluid control.

Why not send today for your free copy of Valve Reference Book No. 39-5? *It shows sizes, types and pressure ratings for Homestead-Reiser Valves.*

How the "*Self-Sealed*" Principle Works

In addition to a full lubricant seal around the ports and around the top and bottom of the valve, the wedge-action of the plug under line pressure, constantly presses the finely-finished surfaces of the plug outward against the seating surfaces of the body. This self-sealing action keeps the plug surfaces in contact at all times with the mirror-like bore of the body. The plug thus automatically adjusts itself for wear, assuring extra long life and maximum leakless service.



Write today for Reference Book 39—Section 5

HOMESTEAD VALVE MANUFACTURING CO.

"Serving Since 1892" P. O. Box 16 Coraopolis, Pa.

You get a great deal

When You Buy Wolverine Condenser Tubes

Quality Controlled
FROM ORE TO FINISHED PRODUCT.

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MANUFACTURERS OF SEAMLESS, NON-FERROUS TUBING
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WITH THESE heads you win

Long-surface swing-frame head, for tubes of wide tolerance.

Type H-2 head, for uneven coke deposits.

Type UO head, for average coke conditions.

Type UHC head, for extremely heavy coke.

in the fight against coke. You win a thorough cleanout job . . . relative freedom from the delays of tube cleaner failure . . . and a big cut in timeout for cleaning stills.

Whatever your coke condition, one of these LAGONDA cutter heads will handle it—backed by the powerful LAGONDA 1100 Series motor. With its free-spinning ball bearings and full front-and-rear lubrication this motor puts practically all the power right through to the cutter head for a smashing attack on coke and the quick resumption of production.

IT GRINDS BOILER HANDHOLE SEATS TRUE

The ELLIOTT Handhole Seat Grinder can be quickly clamped into position, with the grinding wheel operating inside the handhole on a true plane, refacing the gasket seat with extreme accuracy. No more leaking handholes after you use this modern and accurate method. Write us for the bulletin and full details.

Some of the reports we get about time saved with LAGONDA tube cleaners, lead us to believe that the cooperation of a LAGONDA tube cleaning specialist could be very well worth while in many refineries. Why not utilize this expert cooperation? No obligation. LAGONDA bulletin, with full data, mailed at request.

Y-287

Lagonda TUBE CLEANERS

ELLIOTT COMPANY • Lagonda Division • SPRINGFIELD, OHIO

Plants at: JEANNETTE, PA. • RIDGWAY, PA. • AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.

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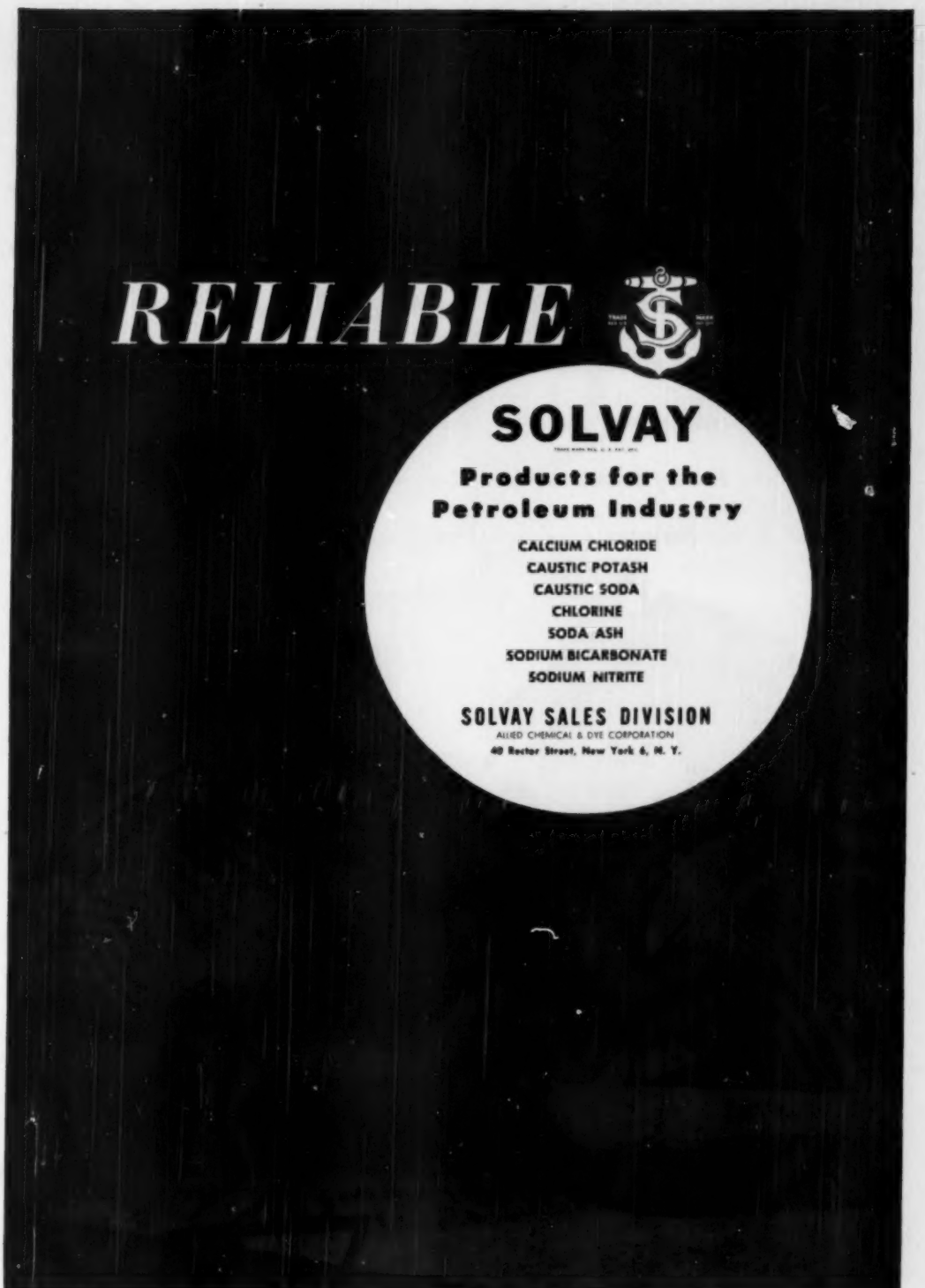
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40 Rector Street, New York 6, N. Y.

stressing SERVICE

During many years of desalting activity, Petreco has stressed always the importance of fast, effective service. When refiners cite benefits such as more time on stream, lower maintenance costs and increases in refining capacities, we know that such benefits result directly from Petreco's high efficiency salt removal. However, we also believe that the Petreco service organization, whose know-how and experience are unequalled in the industry, is of substantial assistance in providing more profitable refining through more efficient desalting.

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DESALTING

PETROLEUM RECTIFYING COMPANY
5121 S. WAYSIDE DRIVE • HOUSTON 1, TEXAS
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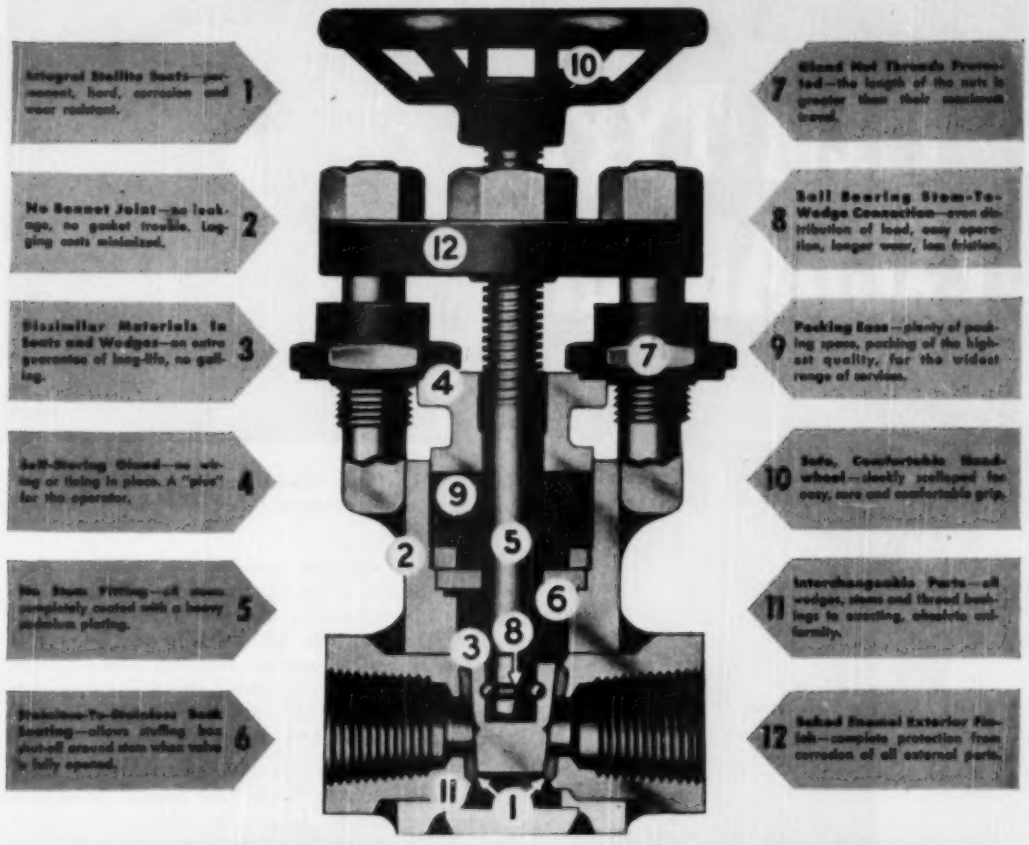
PETRECO

SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR-49-4


1 Integral Stellite Seats—permanent, hard, corrosion and wear resistant.
2 No Bonnet Joint—no leakage, no gasket trouble. Lagging costs minimized.
3 Dissimilar Materials in Seats and Wedges—an extra guarantee of long-life, no galling.
4 Self-Storing Gland—no wiring or fixing in place. A "plus" for the operator.
5 No Stem Fitting—all stem completely coated with a heavy cadmium plating.
6 Stainless-To-Stainless Ball Bearing—allows stuffing box shut-off around stem when valve is fully opened.
7 Gland Nut Threads Protected—the length of the nuts is greater than their maximum travel.
8 Ball Bearing Stem-To-Wedge Connection—even distribution of load, easy operation, longer wear, less friction.
9 Packing Boss—plenty of packing space, packing of the highest quality, for the widest range of services.
10 Safe, Comfortable Handwheel—sleekly scalloped for easy, sure and comfortable grip.
11 Interchangeable Parts—all wedges, stems and thread bushings to exacting, absolute uniformity.
12 Baked Enamel Exterior Finish—complete protection from corrosion of all external parts.

TOUGH and TIGHT

They're known, in a large oil company, as "those tough and tight valves" . . . they combine twelve superiorities available in no other valve . . . they're modern in every detail even to the safe, comfortable, sleekly scolloped hand wheel. They're the *general purpose* Hancock Steel Gate WELDVALVES . . . Check them for yourself. You'll find that Hancock Gate WELDVALVES will take the toughest services, stay tight month-after-month . . . Costing no more than ordinary valves, Hancock Gate WELDVALVES give you integral stellite seats that mean years of trouble-free operation; a modern, functional design that eliminates bonnet leakage and gasket troubles, and ten other reasons why their usage is growing every day . . . Hancock Steel Gate WELDVALVES are designed for 800# at 750 deg. F. or 2000# at 100 deg. F. Sizes up to 2 inches.

Write today for the new Bulletin 202 on General Purpose Hancock Steel Gate WELDVALVES.

MANNING MAXWELL & MOORE INC. TRADE MARK

HANCOCK *Valves*

1877 HANCOCK U.S.A.

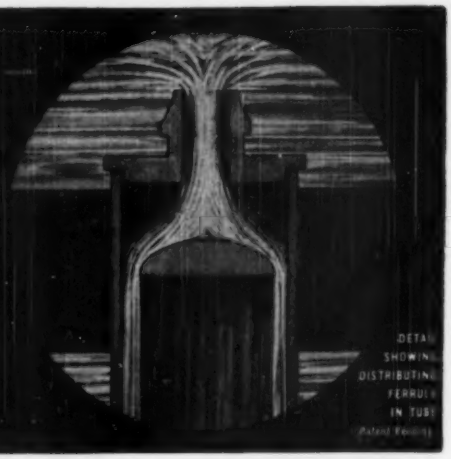
A PRODUCT OF

MANNING, MAXWELL & MOORE, INC.

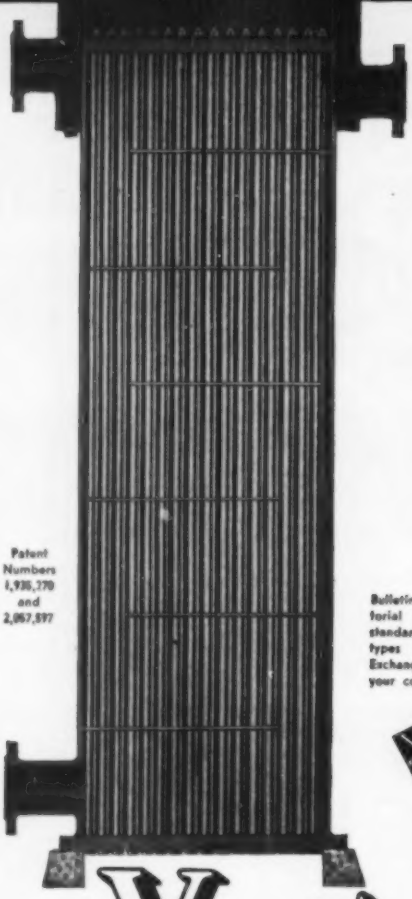
WATERTOWN 72, MASSACHUSETTS

Makers of Hancock Valves, Ashcroft Gauges, Consolidated Safety and Relief Valves, American Industrial and [illegible]

FILM TYPE EXCHANGERS



DETAIL SHOWING DISTRIBUTING FERRULE IN TUBE



Patent Numbers 1,935,270 and 2,067,597

Vogt engineers have taken a familiar refrigeration plant "old timer" and developed it into this modern, efficient heat exchanger.

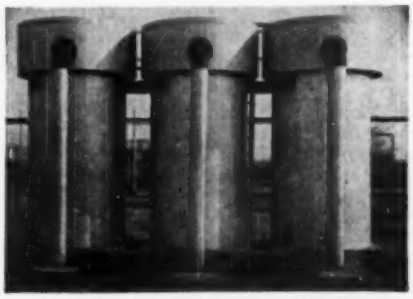
The film type exchanger operates in a vertical position. Water introduced in the top chamber is distributed in a thin film against the inner tube walls by means of special ferrules. The shell side of the exchanger has baffles arranged to provide optimum velocities, pressure drops, and heat transfer rates. Shutdowns are eliminated because tubes can be cleaned while the unit is in operation; thus permitting the use of dirty, mud and silt depositing water.

Vogt Film Type Exchangers now serve as Jacket Water Coolers, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to condense any vapor. They are also applicable for handling liquids other than water in film flow.

HENRY VOGT MACHINE CO., INC.
LOUISVILLE 10, KENTUCKY

Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas

Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for your copy.



Jacket Water Coolers serving engines of 7,300 H.P. Muddy well water used as cooling medium.

Vogt

HEAT TRANSFER EQUIPMENT

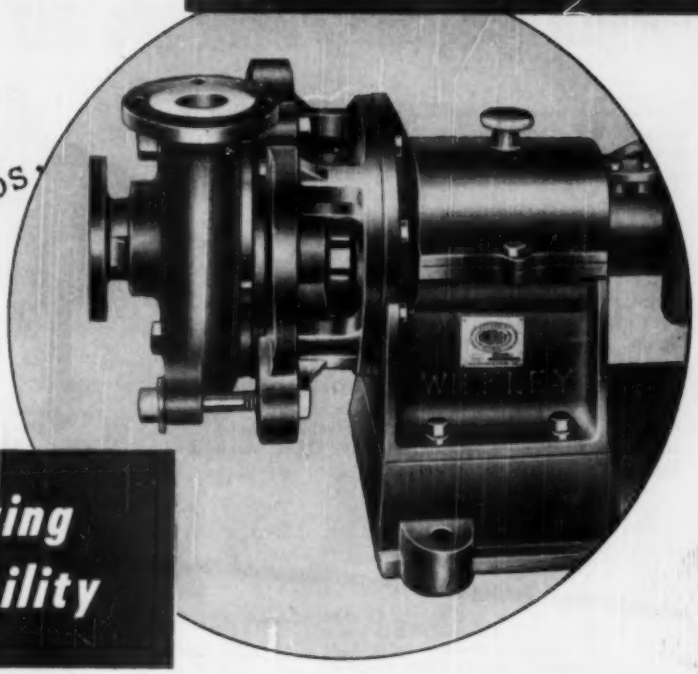
WILFLEY *Acid* PUMPS

Substantial Savings

IN HANDLING ACIDS,

CORROSIVES,

HOT LIQUIDS



• HOT LIQUIDS • CORROSIVES • HOT LIQUIDS • CORROSIVES • HOT LIQUIDS •

Cost-Saving Dependability

WILFLEY pumps are trouble-free. They operate without attention...carry the load easily and economically. Production records in today's most modern chemical plants prove the cost-saving dependability of these highly efficient pumps. 10- to 2,000-G.P.M. capacities; 15- to 150-ft. heads and higher. Individual engineering on every application. Write or wire for specific details.

A Companion
to the FAMOUS WILFLEY
Sand Pump

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Buy WILFLEY for
Cost-Saving Performance

A. R. WILFLEY & SONS, Inc.
Denver, Colorado, U. S. A.
New York Office: 1775 Broadway
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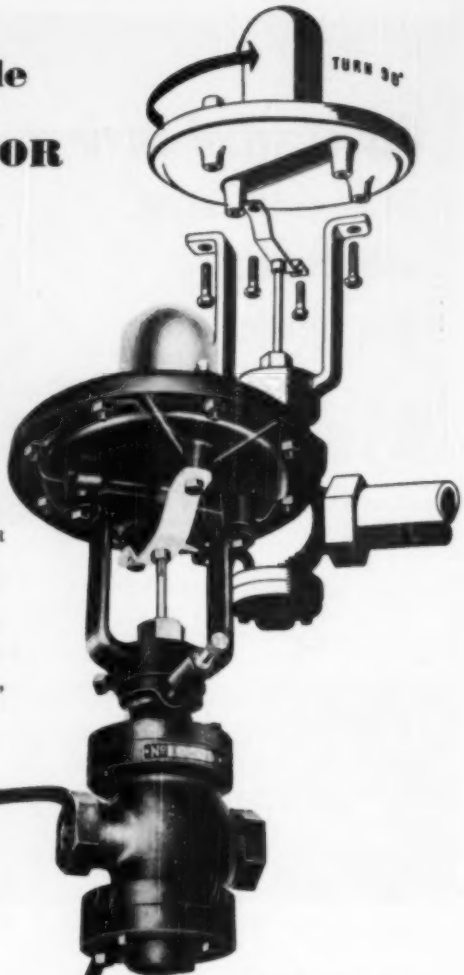
WILFLEY *Acid* PUMPS

NEW! Quick-Reversible STABILFLO VALVE MOTOR

makes a 2-in-1 control valve



By a simple, ingenious application of relative-motion principles, Foxboro has developed a new valve motor to provide foolproof, almost instant reversibility of valve action. With it, valve action can be changed in four simple steps . . . unbolting diaphragm motor, rotating motor 90 degrees, rebolting motor and shifting air connections. That's all!

This new diaphragm motor brings you *convenience* never before available. It makes it possible to reduce valve *inventories*. And it permits you to standardize, throughout your plant, on the friction-free floating power that has helped make Foxboro Stabilflo Valves the standard of performance in all process industries.

Get all the facts about this new cost-saving development. Write for Bulletin on Quick-Reversible Stabilflo Valve Motor . . . the motor that now makes possible a 2-in-1 control valve. **The Foxboro Company, 74 Neponset Ave., Foxboro, Mass., U. S. A.**

Diagram A shows air-to-close action of a typical Foxboro valve body equipped with the new reversible motor. Yoke is rigidly attached to diaphragm motor housing and valve stem moves integrally with diaphragm plate. Air pressure is always on the same side of diaphragm whether on an air-to-close or air-to-open action.

Diagram B shows air-to-open action. Here motor has been turned 90 degrees. Now mounting lugs of diaphragm motor housing, originally bolted to yoke, are bolted to valve stem strap and lugs on diaphragm plate are bolted to yoke. Although diaphragm plate is rigidly attached to yoke, the diaphragm is free to move.

QUICK-REVERSING ON LINE. No need to remove, reverse and re-install valve

NO SPECIAL TOOLS NEEDED. Simple job . . . standard tools

NO MECHANICAL SKILL NEEDED. Valve action can be changed without services of a specialist

A DUAL-PURPOSE, QUALITY VALVE. Now, the widely-used Stabilflo Valve featuring 50-to-1 rangeability with uniform characteristics is available with this new cost-saving feature that makes it 2 valves in 1.

FOXBORO
REG. U. S. PAT. OFF.

STABILFLO CONTROL VALVES

PLUGS ARE OUT WITH CHLORINATION

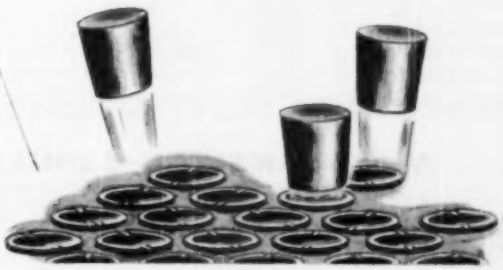
Costly plug cleaning, with its high labor bills and lengthy equipment down-time, goes out of the condenser and heat exchange picture the minute chlorination arrives.

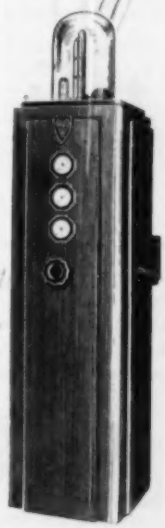
This proven process for cutting the costly effects of back pressure and poor heat transfer characteristics caused by slime, really works, as one Southern Power Station found out when they began using the W&T De-sliming Process. In just six months after W&T Chlorinators were installed, cleaning and excess steam costs were reduced from $1450 per month to $250 per month and a later survey showed an overall saving in excess steam costs of $16000 in a year.

Such savings are indicative of how your condensers may be made to operate more economically and with far less outage when W&T Engineers install chlorination to fight your slime problems.

To learn how chlorination may be profitably applied to your heat exchange equipment and to take advantage of W&T's 35 years' experience, write today.

WALLACE & TIERNAN
PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities



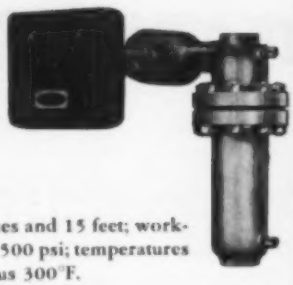


CD-31

MASONEILAN EQUIPMENT IMPROVES PROCESS CONTROL

12000 SERIES DISPLACEMENT TYPE LIQUID LEVEL CONTROLLERS

For all usual liquid level control, measurement and signaling applications, including interface service.



Ranges

Between 14 inches and 15 feet; working pressure to 1500 psi; temperatures to 750°F or minus 300°F.

Level Instrument Mechanisms

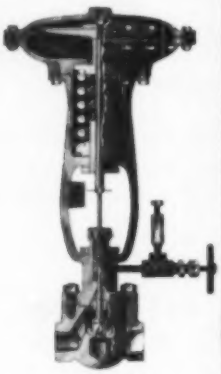
Two position Differential-Gap, Proportional or Proportional-Reset Control; Pneumatic Transmission; Pneumatic Signal Switch; Duplex Control; Control plus Pneumatic Transmission or Pneumatic Signal Switch.

NO. 2700 PRESSURE CONTROLLER

These controllers are designed for many industrial applications requiring accurate control where more expensive instruments are not warranted. Ranges between 30" Hg. Vac. and 1000 psi. Standard proportional band 3 to 50%.

CONTROL VALVES

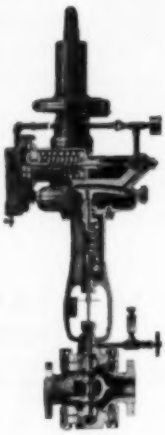
No. 38
Percentage V-Port
Control Valve



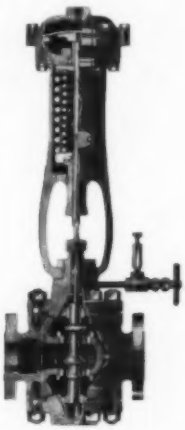
No. 37
Percentage Piston
Control Valve

No matter what the application — temperature, pressure, level and flow, there is a Masoneilan control valve designed to meet the requirements. They are available in a wide range of types and sizes from $\frac{1}{16}$" orifice and up.

REDUCING PRESSURE REGULATORS



No. 27



No. 35

These Regulators have a wide variety of controlled pressure ranges and are accurate within each range. Standard sizes from $\frac{1}{2}$" to 8".

MASONEILAN

MASON-NEILAN REGULATOR CO.
1182 ADAMS STREET, BOSTON 24, MASSACHUSETTS, U. S. A.

Sales Offices or Distributors in the Following Cities — New York • Syracuse • Chicago • St. Louis • Philadelphia • Houston • Denver • Pittsburgh Cleveland • Cincinnati • Tulsa • Atlanta • Los Angeles • San Francisco • Salt Lake City • El Paso • Boise • Albuquerque
Mason Neilan Regulator Company, Ltd., Montreal and Toronto

At right is the Chemico field office at Muscle Shoals where nitrate was produced during World War I. Above is the Construction Administration Area of the Jayhawk Ordnance Works, a Chemico World War II project.

"Experience

is the surest standard by which to test" WASHINGTON

CERTAINLY George Washington's yardstick of experience can be used to evaluate a business organization. It's the "surest standard", in fact, when you entrust responsibility for the design and construction of a heavy chemical plant.

Chemico is long on this valuable experience. Its record of building profitable plants goes back to 1914. Chemico played a vital role in two world wars . . . aided the development and expansion of industry throughout the world in times of peace.

During the past 36 years, Chemico has pioneered in the development of new and improved processes for the recovery and production of sulfuric acid and the production of nitric acid, synthetic ammonia and other heavy chemicals. Today, Chemico enjoys an international reputation in the field of chemical plant design.

This broad experience is the basic reason why Chemico-built plants deliver their full capacity year in and year out . . . why they operate at high efficiency with a minimum manpower requirement . . . why they have proved to be profitable investments.

If you are planning to build a heavy chemical plant or remodel an old one, entrust the project to Chemico—the firm with the widest and longest experience.

Typical Chemico Undertakings

PLANTS FOR PRODUCTION OF

SYNTHETIC AMMONIA
SYNTHETIC METHANOL
DOUBLE SUPERPHOSPHATE
AMMONIUM PHOSPHATE
AMMONIUM SULFATE
AMMONIUM NITRATE
CALCIUM NITRATE
FORMALIN

PLANTS FOR PRODUCTION, CONCENTRATION AND RECOVERY OF

HYDROCHLORIC ACID
NITRIC ACID
PHOSPHORIC ACID
SULFURIC ACID

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

EMPIRE STATE BLDG., 350 FIFTH AVENUE, NEW YORK 1, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE
CYANAMID PRODUCTS LTD., BRETTENHAM HOUSE, LANCASTER PLACE, LONDON W. C. 2, ENGLAND
EUROPEAN LICENSEE OF N. E. C. PROCESS
HYDRO-NITRO S. A., 8 QUAI DU CHEVAL BLANC, GENEVA, SWITZERLAND
CABLES: CHEMICONST, NEW YORK

CC 192

Chemico plants are profitable investments

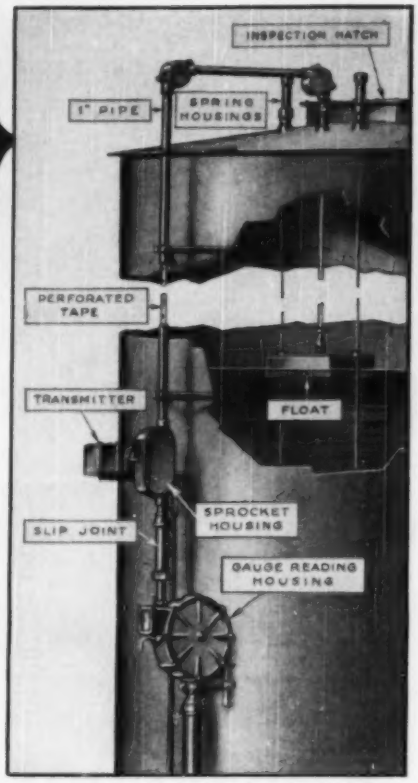
THE AMERICAN WAY

Greater Convenience
Maximum Safety
Consistent Accuracy
Economical Operation

By pressing a button of the double Selsyn selective receiver in the control room, the operator can tell instantly the gallonage in any given tank, and can follow the filling and draining of storage tanks to cars or barges.

At the docks is another explosion-proof receiver, where, by merely pressing a button, the operator can tell instantly the gallonage which has been pumped into a storage tank, or the amount which has been withdrawn. Such close control of operations prevents waste of product, damage to tanks, and permits accurate timing of loading and unloading operations.

Photos by courtesy of Standard Oil Company (Indiana).

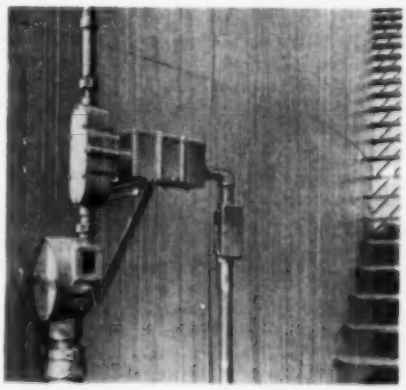


The picture above shows the component parts of the S. & J. Remote Reading Automatic Tank Gauge as installed at each storage tank. In addition to the automatic reading sent by the transmitter to the receiving station, another reading can be taken at the tank at eye level from the tape in the gauge housing.

To do a given job quickly, accurately, and safely—that's the American way of mass production which brings the good things of life within the reach of all the people. American industry does not send a workman to do a hazardous job, like gauging a petroleum storage tank manually, if the job can be done instantly and safely by merely pressing a button. Study the pictures reproduced here and see how a great American oil company uses S. & J. Remote Reading Automatic Tank Gauges to take inventory and to follow the filling and unloading of their storage tanks. Multiply the economy obtained here by a thousand other operations handled equally efficiently, and you will understand why every AMERICAN workman can buy gasoline cheaper than it is sold in any other country on earth.

SHAND & JURS CO.
BERKELEY, CALIFORNIA

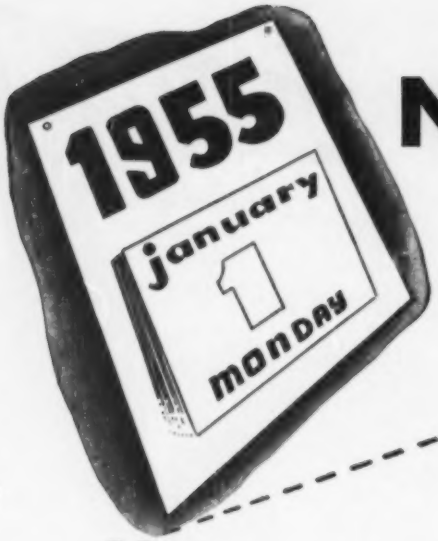
NEW YORK CHICAGO HOUSTON
LOS ANGELES SEATTLE



Close-up view of the transmitter as installed at the tank by Standard Oil Company (Indiana).

SHAND & JURS

*FISHER
AMT
DIAPHRAGM
MOTORVALVES
* "ANSWER ME TWICE."—IN ACTION, PRESSURE ADDED TO ONE DIAPHRAGM, SUBTRACTED FROM OTHER.
HEAVY DUTY
HIGH PRESSURE
SERVICE
FISHER GOVERNOR CO., Marshalltown, Iowa



No, not yet, but....

MARLEY FANS, GEAREDUCERS, DRIVE SHAFTS AND FAN CYLINDERS ARE *FIVE YEARS AHEAD* IN THE FIELD OF COOLING EQUIPMENT . . . since, the HEART of any Cooling tower or DriCooler is these mechanical units, their dependability and performance are of the utmost importance.

Just imagine mechanical equipment of any type . . . particularly 22 foot fans powered by 75 brake horsepower . . . operating 24 hours a day in the midst of a hot, dank jungle! Yet, this is the atmospheric condition under which mechanical units must perform on water cooling equipment.

Recognizing this fact, and realizing that commercial-type equipment was not available to meet these severe conditions, The Marley Company, Inc., decided in the early thirties to design and produce their own.

Today, Marley offers newly designed Geareducers, fans, fan cylinders and drive shafts . . . developed not from theory, not from a few scattered tests over one or two years' time, but backed with the "know-how" gained from MORE THAN 5000 UNITS actually in operation over the past fifteen years! This is 5 TIMES THE EXPERIENCE OF ANY OTHER manufacturer.

Of course, your next Marley DriCooler or Cooling Tower will have this "years ahead" mechanical equipment. But, you can modernize your present installation, if you wish, with Marley mechanical equipment which is now available in a range of sizes to fit most any cooling unit.

If you would like to know more about Cooling Tower or DriCooler Operation, Maintenance, Testing, Water Distribution, Specifications, Water Treatment, Air Movement, and other vitally important cooling problems, MAIL THE COUPON or write today for free, illustrated folders.

MAIL THIS COUPON TODAY

The Marley Company, Inc., Kansas City 15, Kansas PR-1

☐ Yes, I would like to have your FREE, illustrated folders on cooling problems.

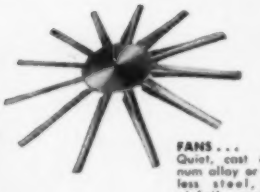
☐ Please have salesman call to discuss our cooling problem.

Name _____ Title _____

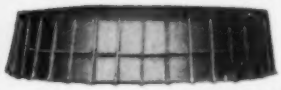
Company _____

Street Address _____

City _____ State _____



FANS . . . Quiet, cast aluminum alloy or stainless steel, true airfoil sections, adjustable pitch, smooth, efficient, balanced.



FAN CYLINDERS . all bolted construction (not nailed together) tapered throat, non-corrosive materials, high enough for safety, low enough for easy inspection, sized to give close fan tip clearance.

GEAREDUCERS . . . heavy cast iron cases, case hardened nickel-moly steel gears, Porco lubrized pinions, positive lubrication forward and reverse, sized and geared to meet operating horsepower.

DRIVE SHAFTS . . . Heavy tubular steel with integral yokes, Flex-disc couplings, balanced for smooth operation, do not require lubrication.

MARLEY

NORDSTROM VALVES

now automatically lubricated with

Hypermatic

TRADE MARK

Easier than ever to operate

Kept fully lubricated, automatically

Maintenance time deeply cut

Self-feeding, self-sealing

Leakage avoided, automatically

•

Ask for Bulletin V-211 describing Hypermatic Lubricant

Nordstrom Valve Division

ROCKWELL MANUFACTURING CO.

400 N. Lexington Avenue • Pittsburgh 8, Penna.

Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa.
Also leading supply houses

Export: Rockwell Manufacturing Co., International Division, 7701 Empire State Building, New York 1, N. Y.

The Tanks are Elevated

NOT THE PRICES!

Posey is Equipped to Do the Complete Job...from **(1) Design to (2) Fabrication to (3) Erection**

Posey Iron believes that there's no need to elevate prices on elevated tanks. Posey long ago adopted its own inflation resistance program . . . has never raised prices simply to follow the "trend". Instead, Posey engineers bear down to eliminate cost-padding frills and unnecessary steps of construction . . . overlook nothing that will permit estimates that are low *for workmanship of high integrity.*

Posey tanks are welded steel throughout . . . with no rivets where corrosion might gain a foothold. With interior surfaces as smooth and curved as those of a fine ball bearing, Posey Tanks are leak-free . . . corrosion resistant.

Let us know your conditions and we may be able to show you how Posey elevated storage tanks can increase capacity . . . aid production . . . reduce maintenance . . . and perhaps eliminate expensive equipment. Write today. No obligation.

POSEY IRON WORKS, INC.

formerly **LANCASTER IRON WORKS, INC.**

LANCASTER, PA., U.S.A.

TANKS
WROUGHT IRON, STEEL
AND ALLOY STEEL PIPE
O. D. PIPE

TEES
ELBOWS
AUTOCLAVES
STEEL PLATE CONSTRUCTION

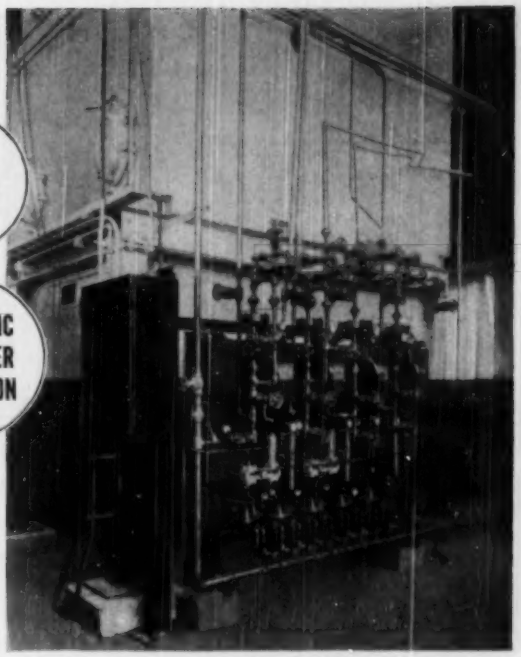
AUTOMATIC COMBUSTION CONTROL

RING BALANCE METERS

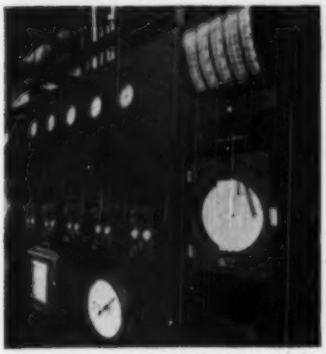
BY HAGAN

AUTOMATIC FEEDWATER REGULATION

AT THE CLEVES, OHIO, REFINERY OF THE GULF REFINING COMPANY

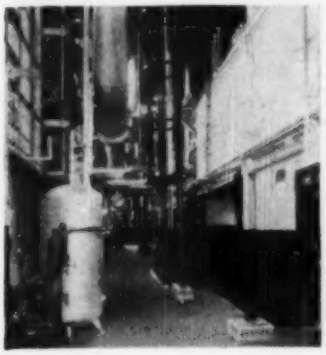


Components of the Hagan automatic feedwater regulation and combustion control systems are mounted at the side of each boiler, giving easy access for adjustment or servicing.



Separate instrument panels are provided for each boiler. Two Hagan Ring Balance Meters are mounted on each panel.

Below—General view showing front of boilers and instrument panels in Gulf Refining Company refinery at Cleves, Ohio.



Recent expansion of the refinery of Gulf Refining Company at Cleves, near Cincinnati, included the installation of two new boilers, each with a capacity of 70,000 pounds of steam per hour, and operating at 685 psi. Fuels used are refinery waste gas and oil, either singly, or in combination.

These new boilers are equipped with Hagan Automatic Combustion Control, Hagan Automatic Feedwater Regulation, and Hagan Ring Balance Meters.

The combustion control is a Hagan Differential Master system. With this system, waste gas is burned when available and is automatically supplemented or replaced by oil as necessary. Fuel feed is changed instantly to compensate for fluctuations in calorific value of fuel or changes in steam demand and excess air is automatically maintained in accordance with actual Btu. input.

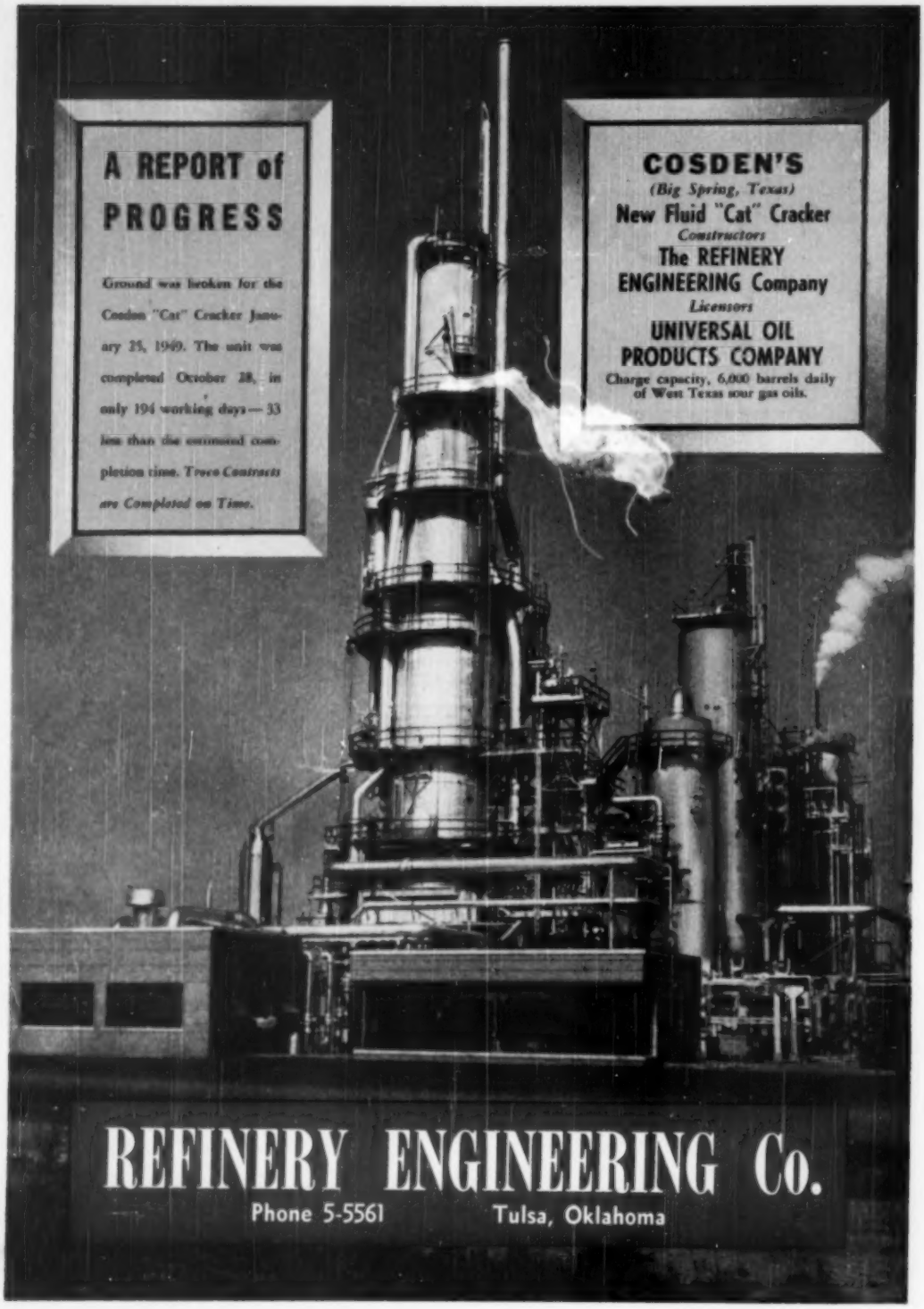
Hagan Automatic Feedwater regulation is a multiple circuit system which proportions feedwater to steam flow and modifies feedwater flow in accordance with water level in the boiler. Thus the system not only holds water level accurately in a steady steaming state, but also "irons out" in an optimum pattern, the mutual disturbances existing between the steam generating circuits and the water flow circuits of the boiler in changing from one steam rate to another.

Two Hagan Ring Balance Meters are used with each boiler. One records steam flow, air flow and steam pressure; the other records feedwater flow and steam drum water level.

We will be glad to supply full information on Hagan Combustion Control, Hagan Automatic Feedwater Regulation and Hagan Ring Balance Meters. Write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES


A REPORT of PROGRESS
Ground was broken for the Cosden "Cat" Cracker January 25, 1949. The unit was completed October 28, in only 194 working days — 33 less than the estimated completion time. Two Contracts are Completed on Time.
COSDEN'S
(Big Spring, Texas)
New Fluid "Cat" Cracker
Constructors
The REFINERY ENGINEERING Company
Licensors
UNIVERSAL OIL PRODUCTS COMPANY
Charge capacity, 6,000 barrels daily of West Texas sour gas oils.
REFINERY ENGINEERING Co.
Phone 5-5561
Tulsa, Oklahoma

Oh Lord, I Am Thankful

R. L. DUDLEY

OH LORD, I am thankful.

I am thankful that I live in a land where I can express my thanks to Thee, instead of being forced to go through the sham of thanking a dictator or a bureau for that which I have received.

I am thankful that my endeavors are selected by me, directed by me, and that I still have a substantial measure of control over part of the rewards for my own work.

I am thankful that, if my instincts are to share with my fellow men either of my time or my substance, I may, to a great extent, choose the less fortunate with whom I share.

I thank Thee, Oh Lord, for the right to speak and write as I will because if such right were taken from me, I would be little better than the dumb beasts of the field.

I thank Thee that, though ill feeling and even hatred seem to grow in our own country, still there lies between me and those with whom I daily come in contact a feeling of kindliness, and I pray Thee, Oh Lord, that such feeling of kindliness never be taken from our land.

I thank Thee that my right to worship is unrestrained. This, though I am too little a person of church form and creed, I know and appreciate, is a priceless heritage bequeathed by our forefathers, and I know that, though rivers of blood have flowed to help guarantee this right, there are today countries on our earth where Thy worship, in any form, may be undertaken only at risk of liberty or life.

I thank Thee that my posterity may be educated after the manner of my choice or the choice of their immediate parents without having them trained through organized propaganda to disregard the things which, since I have reached the age of accountability, I have known to be good.

I thank Thee that I may go from place to place, freely, in the pursuit of my work, or my happiness, with no ban imposed upon me because my travels do not fit into the pattern of a planned state or a dictator's whim.

I thank Thee that in our land even yet, in the face of all onslaughts, honor and integrity are highly regarded, that conscience has not been stilled altogether in high places but that the germ of decency is a germ within the hearts of most of those who live within our boundaries. I pray that this germ may grow.

I thank Thee, Oh Lord, for this generation of young men both in our countries and in the countries of our late allies—for without their sacrifice these thanks which I give to Thee this day might well be changed to a cry for help.

Oh Lord, there are **so many** things for which I am thankful!

But let me close my thanks with this prayer:

Oh Lord, give me the wisdom always to see and know the right. Give me the courage to say the things I know to be right, regardless of the effect upon me, and make me appreciative of the things which, when all is said and done, are best for all.

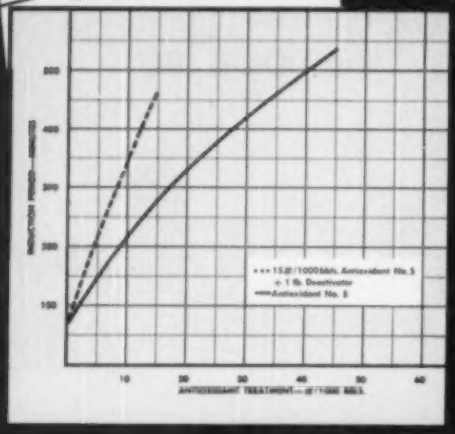
New Metals in Process Plants

METALLURGISTS have played a larger part in the development of today's process plants than is generally realized. As operating conditions of temperature and pressure and exposure to corrosive effects have repeatedly made more severe by new process techniques, the limiting factor has repeatedly been the materials available for the construction of process equipment.

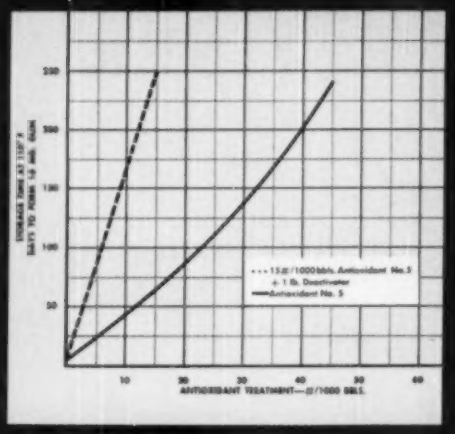
The makers of these materials have to a remarkable degree met the challenges offered, and we

PHOTO AT TOP OF THIS PAGE—General view of Continental Oil Company's recently opened refining plant located at Billings, Mont. The 7500-barrel-per-day plant includes crude oil distillation, propane de-asphalting, fluid catalytic cracking, fluid catalytic desulfurization, catalytic polymerization, and liquefied petroleum gas facilities.

CASE HISTORY:


INDUCTION PERIOD—MINUTES
ANTIOXIDANT TREATMENT—#/1000 BBLS.
+++15#/1000bbls. Antioxidant No. 5 + 1 lb. Deactivator
—Antioxidant No. 5

Results of induction period tests on stock containing 0.1 parts per million of copper, using Du Pont Antioxidant No. 5 alone, and combined with Du Pont Metal Deactivator.


STORAGE TIME AT 110° F DAYS TO POUR UP ASTM D97
ANTIOXIDANT TREATMENT—#/1000 BBLS.
+++15#/1000bbls. Antioxidant No. 5 + 1 lb. Deactivator
—Antioxidant No. 5

Results of accelerated storage tests on the same stock using Antioxidant No. 5 alone and in combination with Du Pont Metal Deactivator.

Du Pont Metal Deactivator *Saves 48% in* Antioxidant Treating Costs

As little as 0.1 parts per million of copper is barely measurable by ordinary analytical methods . . . yet in some gasolines it may be enough to almost double antioxidant treating costs.

In this actual case history, to obtain a 460 minute induction period, thirty-five pounds of Du Pont Antioxidant No. 5 per thousand bbls. were required. This antioxidant was selected as the most effective of the three Du Pont Gasoline Antioxidants for use in this particular gasoline. The addition of one pound of Du Pont Metal Deactivator reduced the antioxidant requirements for the same induction period to fifteen pounds, a dollar saving of 48%.

Under actual, but accelerated, storage conditions, the pattern was the same.

Here is documented proof of the effectiveness of Du Pont Metal Deactivator in stocks containing traces of dissolved copper. In accelerated oxidation tests, response to Du Pont Metal Deactivator often shows the presence of copper that has not been detected by ordinary analytical methods. Du Pont District Laboratories will be glad to run a Metal Deactivator test on your stocks for you. Just call your Du Pont Petroleum Chemicals representative.

DU PONT
REG. U.S. PAT. OFF.

Better Things For Better Living ...Through Chemistry

Petroleum Chemicals

Make Du Pont the Source for All of Your Gasoline Additives . . . Tetraethyl Lead Compounds (Motor Mix – Aviation Mix) – Antioxidants – Metal Deactivator – Dyes

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

District Offices: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

now have reasonably satisfactory materials for the majority of process equipment needs. There is, of course, room for improvement. Further advances in the materials field will quite certainly make possible improvements in process plant techniques that would not otherwise be practical. The advances are being made. Evidence of this continued development are recent announcements of a ductile cast iron and of a low-carbon stainless steel.

The "ductile cast iron," first announced by The International Nickel Company in May, 1948, is a high carbon ferrous product containing graphite in the form of spheroids. This company explains that ordinary gray cast iron has its graphite in the form of flakes which form a multitude of notches and discontinuities in the metallic matrix. It is a relatively weak and brittle material. By contrast, the new ductile cast iron contains graphite in the form of spheroids or impacted particles. They say that ductile cast iron enjoys the same advantages that have made gray iron a popular and widely used casting material for so many centuries. Ductile cast iron has a low melting point, exceptional fluidity and good machinability. Because of the flexibility and quality of its mechanical and physical properties it is said that this new engineering material closes the gap which existed previously between cast iron and cast steel. Applications for which the new metal appears to be especially well adapted include the following: 1) Castings requiring mechanical properties better than those of gray cast iron yet which are too intricate to be cast in steel; pipe products requiring good strength, toughness, and pressure tightness. The fluidity and good casting properties of ductile iron make it ideal for this and other pressure castings; 2) Castings requiring better impact resistance than ordinary cast iron because of exposure to load shocks in regular service. Many parts of construction machinery are in this category; 3) Parts requiring good rigidity to minimize deflection from their weight and working loads will benefit from the high modulus of elasticity, 25,000,000 psi.

Low-carbon stainless steels were announced in December, 1949, by Carnegie-Illinois Steel Corporation, a subsidiary of United States Steel. The company states that it is ready for commercial production of 0.03 percent maximum carbon stainless steels. Potentially useful in chemicals and hydrocarbon processing plants, low-carbon stainless has high resistance to intergranular corrosion.

Up to the present it has been necessary to add solumbium or titanium to austenitic stainless steels as "stabilizers" to minimize the adverse effects of carbon and thereby render the alloy less susceptible to intergranular corrosion. The supply of these elements is sometimes critical. Conservation is served by avoiding their use unless absolutely necessary.

Carnegie-Illinois has been working on the problems involved in the commercial manufacture of low-carbon chrome-nickel stainless steels since 1939. Concurrently with the development of manufacturing techniques extensive corrosion testing programs were set up. It has taken a decade to prove that the manufacturing methods are economically sound and to accumulate sufficient corrosion testing data to justify consumer acceptance of 0.03 percent maximum carbon stainless steels for use in many applications in which columbium or titanium stabilized steels were formerly used.

The testing program has indicated that, on the basis of established standards, the 18-8 steels containing not more than 0.03 percent carbon have a resistance to intergranular corrosion equivalent to that of the 18-8 columbium and titanium stabilized stainless steels. Welding tests have confirmed these results.

Better Lube Oils — When?

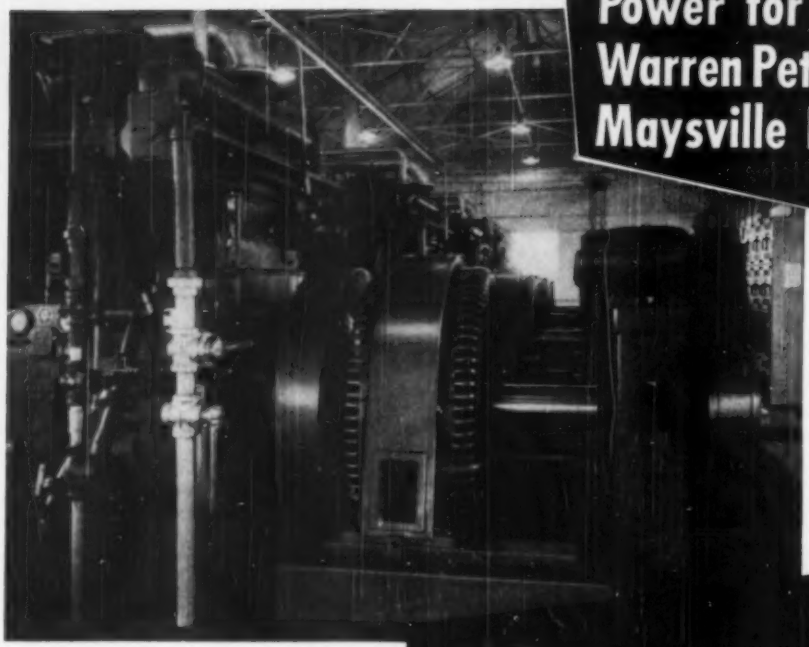
LUBRICATING oil technologists are working continually to build better lube oils for automotive engines. Probably the oils of most interest to the refining industry at the present time are those that have been under discussion for the past two years —high additive content lube oils. These oils are compounded to provide greater oxidation stability, less bearing corrosion, and less corrosion from the products of combustion on rings and cylinders. The final purpose of the new oils being, of course, a reduction in wearing of moving parts that could be accomplished by oil.

These oils have not been offered for automotive engines as new and better oils. As a matter of fact, there does not appear to be a great deal of information on the performance of these oils in automotive engines. The oils actually were developed as heavy duty lubricating oil for diesel engines and their manufacturers do not appear to have gotten around to informing the motoring public that superior lubricating oils are available, or that they are on the way.

This may or may not be an oversight on the part of lube oil producers, because some of the new oils contain as much as 12 percent additive and the cost of the oil is approximately twice as high as premium grade motor oils at present. There may be a question as to whether the producers want to continue selling oil with a low percentage of additive at a low price, or sell a better oil at a higher price—a super-premium oil.

At any rate, it is to be hoped that the motoring public will have the opportunity, in the near future, to avail themselves of the improvements made in new lube oils.

Power for Warren Petroleum's Maysville Plant

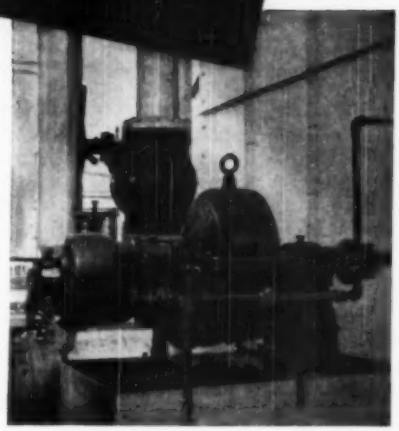


Elliott
GENERATORS AND TURBINES

Four smooth-running Elliott generators, driven by Ingersoll-Rand gas engines, purr out the power for the Warren Petroleum Corporation Maysville plant. These generators are rated 500 kva, 400 kw, 327 rpm. Their 10 kw, 1750 rpm exciters are V-belt driven and mounted on the pedestal bearing.

The gas for driving these units comes in part from the exhaust of the Elliott mechanical drive turbine (shown at right) which drives a fan in the jacket water cooler. The turbine operates on process gas, at 200 psi, exhausting the gas at 40 psi to the engines and for use in firing the hot oil furnaces.

The selection of Elliott generators and turbine for this pace-setting gasoline plant, is just one more confirmation of the reputation for reliability which Elliott-built equipment enjoys throughout the petroleum industry.



Q-1148

ELLIOTT COMPANY

Electric Power Dept., RIDGWAY, PA.
Steam Turbine Dept., JEANNETTE, PA.

Plants at
JEANNETTE, PA. • RIDGWAY, PA. • AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

Year Brings About Easing Of Industry's Operations

UNSEASONABLY warm weather over a large portion of the heating season and declining export requirements in 1949 eased the oil industry's unprecedented rate of operations in this country for the first time since the early days of World War II.

Domestic demand reached a new high during the year, topping the 1948 record by a slight margin. Total consumption, including exports, dropped below the all-time peak set in the same calendar year, however.

The American Petroleum Institute, in a year-end review of the industry's activities, reported late in December that operations boomed along at near-record levels in 1949, but fell short in many respects of the array of all-time highs set in 1948.

The relatively warm weather in both the first and last quarters was the primary reason because it reduced consumption of fuel oil in areas normally demanding large quantities. Since the industry had been geared for an anticipated increase all along the line, this factor was reflected back in a curtailment of refinery runs, production output and drilling activity.

Exports declined another 40,000 barrels per day on the average, continuing the downward trend which has been the rule of the past five years. This decline is a result of the postwar restoration of refinery operations overseas, and stepped-up production in the Middle East, much of which now goes direct to Europe.

The slow-down in domestic operations marked the first time since 1942 that the annual statistics failed to show increases over those of the preceding 12 months. Fuel oil production dropped for the first time in more than a decade.

Despite the reduction in its basic operations, the oil industry went ahead with its expansion and modernization program in 1949. Investment of capital funds to provide for the oil needs of this country again exceeded $2 billion for the third straight year.

Refinery capacity was boosted another 73,000 barrels per day and rose to an all-time high of 6,550,000 barrels.

Production of motor fuel went over the top in 1949 hitting a total of 960 million barrels. This was an increase of 38 million barrels over the preceding year. The increase in motor fuel demand was the primary factor which pushed domestic demand to a new peak despite the general cutback.

Domestic demand in 1949 was estimated at 2,110,302,000 barrels, an increase of 1,930,000 barrels over 1948.

Total consumption for the year (including exports) was estimated at the rate of 6,105,000 barrels per day, compared with an all-time high of 6,129,000 barrels per day last year.

Production of crude oil in the United States was estimated at 1.8 billion barrels, down 176 million barrels from the preceding year's peak of more than two billion. Production of natural gas liquids

Typical of the petroleum industry's 1949 expansion program was Cit-Con Oil Corporation's new lubricating oil refinery at Lake Charles, La., a project that cost $42 million. Part of its total tank storage capacity of 1.7 million barrels is shown in the photo.

Motor Fuel Produced and Refinery Runs of Crude

(In Barrels of 42 Gallons—000 Omitted)

YEAR	Motor Fuel Produced	Refinery Run of Crude
1939	611,043	1,237,840
1940	616,655	1,294,162
1941	701,204	1,409,192
1942	608,900	1,334,103
1943	608,180	1,429,736
1944	730,340	1,665,694
1945	798,194	1,719,534
1946	776,563	1,730,197
1947	839,958[1]	1,852,245
1948	921,902[1]	2,047,700[1]
1949	960,300[2]	1,939,000[2]

[1] Revised.
[2] Preliminary, subject to revision.

U. S. Petroleum Supply and Demand

(Daily Averages in thousands of barrels)

	1949	1948	1947	1941
SUPPLY:				
Crude Production	5,040	5,509	5,088	3,841
Natural Gasoline, etc.	430	398	364	230
Imports, all Oil	638	513	436	265
Total	6,108	6,420	5,888	4,336
DEMAND:				
Domestic Demand	5,780	5,781	5,452	4,071
Exports, all Oil	325	348	450	300
Total	6,105	6,129	5,902	4,371
Change in Stocks	+3	+291	—14	—35
Total Stocks (million barrels)	607	606	500	556
Refinery Crude Runs	5,310	5,595	5,074	3,860

was up 7,500,000 barrels to 153 million for the year. Thus, total production of liquid petroleum in the United States amounted to an estimated 1.9 billion barrels, a decrease of 188 million barrels under 1948.

Preliminary figures for 1949 place the production of natural gas in the United States at 7.8 trillion cubic feet, representing an increase in the last 25 years of 406 percent. Natural gas distribution by long distance pipe lines was expanded materially in 1949.

Production of natural gasoline and cycle products made from natural gas in 1949 aggregated about 6.5 billion gallons.

The production of liquid fuels from natural gas has increased since 1939 by about 200 percent.

Petroleum refining capacity in the United States has been expanded since 1939 by more than 40 percent. On December 31, 1949, the nation's oil refineries had a combined daily crude oil capacity of about 6,550,000 barrels, compared with a daily capacity at the close of 1939 of 4,721,213 barrels. Crude oil processed by refineries in 1949 was at a daily rate of 5,310,000 barrels, compared with 5,595,000 barrels in 1948. The reduction in the quantity of crude processed in 1949 was necessitated by the reduced demand for heating oils.

Refining capacity in the United States today is more than sufficient to take care of any unusual demand, even under the most severe winter conditions. The oil industry has invested more than $1.5 billion in the last three years in expanding its refining facilities.

More than $100 million was again spent for research and many additional, new products were perfected. With the construction and operation of new pilot plants, the field of petrochemicals was extended greatly in 1949. This is the forerunner of large synthesis plants that are expected to revolutionize the production of chemicals in the United States. Hundreds of millions of dollars are being invested in such projects. In 1949, one-third of all the chemicals produced in the United States was based upon petroleum or natural gas, whereas only 3 percent of the chemicals produced by the rest of the world came from such sources.

Capacity of U. S. Refineries

(Operating—Shut-Down and Building as of Dec. 31, 1949)

(In barrels of crude oil per day)

YEAR	Capacity	YEAR	Capacity
1939	4,721,213	1945	5,398,986
1940	4,860,194	1946	5,731,682
1941	4,999,999	1947	6,401,502
1942	5,087,111	1948[1]	6,477,000
1943	5,311,293	1949[1]	6,550,000
1944	5,337,228		

[1] Preliminary—Subject to revision.

Showdown Soon on ECA Financing of British Oil Plans

HENRY OZANNE, Foreign Editor

THE long-awaited showdown is expected shortly on how far the United States government will finance British oil expansion programs that are directly competing with American operators. Recently the Economic Cooperation Administration (ECA) declared its intention to refuse funds for oil development in foreign countries where the output of such expanded facilities is sold through discriminatory trade practices. Then the British government announced the drastic policy of stopping all fuel oil imports into the United Kingdom beginning January 1, and cutting all gasoline imports by one-third.

This threw the current Anglo-American petroleum talks into confusion after three months of conferences, and the U. S. State Department said it would

Another of 1949's big additions was Gulf Refining Company's $35 million expansion in Ohio. Shown here is R. R. Johnston, general manager of the firm's Toledo division and D. E. Hart, Toledo superintendent, throwing switches to start the big cat cracker at Toledo. Gulf's other big expansion was at Cincinnati.

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European Refinery Projects Approved for ECA Financing

Country and Location of Refinery	Company and Principal Affiliation	Expansion in Capacity (Barrels per Day)	COSTS		
			ECA Dollars[a]	Other Amounts	Total Dollars and Dollar Equivalent[b]
FRANCE:					
Donges, near St. Nazaire	Raffineries Francaises de Petrole de L'Atlantique (French Company)	8,000	$ 750,000	$ 8,685,000	$ 9,435,000
Gonfreville (Seine) and LaMede (near Marseilles)	Compagnie Francaise de Raffinage (French Company)	0[c]	3,150,000	7,850,000	11,000,000
Berre (near Marseilles)	Compagnie de Raffinage Shell-Berre (Royal-Dutch-Shell and French ownership)	26,000	1,850,000	29,800,000	31,650,000
Gravenchon (Seine)	Socony-Vacuum Francaise (Socony-Vacuum Oil Co.)	0[c]	880,000	5,130,000	6,000,000
Port Jerome (Seine)	Standard Francaise des Petroles (Standard Oil Co. (N.J.) majority owner, also Gulf Oil Co., Atlantic Refining Co., and French ownership)	0[c]	1,427,500	4,987,500	6,415,000
ITALY AND TRIESTE:					
Trieste	Aquila S.p.a. Tecnico Industriale (Italian Company)	0[c]	4,250,000	3,700,000	7,950,000
Port Marghera (near Venice)	Societa Industria Raffinazioni Oli Minerali (Azienda Generale Italiana Petroli, and Anglo-Iranian Oil Co., owners)	11,000	1,800,000	4,600,000	6,400,000
UNITED KINGDOM:					
Shell Haven (near London)	Shell Refining and Marketing Co. (Royal-Dutch Shell)	58,000	10,043,000	46,357,000	56,400,000
Llandarcy (Wales)	National Oil Refineries, Ltd. (Anglo-Iranian Oil Co.)	36,100	7,250,000	40,750,000	48,000,000
	Total	$140,200	$31,370,500	$153,879,500	$185,250,000

[a] Amounts authorized to meet dollar exchange requirement for purchase of equipment and engineering services in the United States; in each case the company concerned pays the full amount, in local currency, to the local government.

[b] Calculations for conversion of foreign currencies were made prior to major currency devaluations of September, 1949.

[c] Where no increase in capacity is shown, project involves lubricating oil facilities and other improvements.

intervene with London promptly to see that American oil exporters get "fair and equal treatment" from the British.

The British government called its import-restriction policy necessary to save dollars, but the industry generally sees it as one more step in the attempt to squeeze dollar oil out of the world markets. The British edict hits chiefly three American-owned companies: Anglo-American Oil Company, owned by Standard Oil Company (New Jersey); Vacuum Oil Company, Ltd., a Socony-Vacuum subsidiary; and Cal-Tex, a subsidiary of The California Company and The Texas Company.

These companies have been currently supplying about 140,000 barrels of petroleum daily for the United Kingdom, and under the new curb will be cut down to half that volume. The British companies, Anglo-Iranian Oil and British Shell, will take up the sales lost by the Americans.

Domestic industry officials point out that Britain is able to switch 75,000 barrels daily from dollar to sterling oil because of her increased productive capacity in the Middle East which is being built up by American taxpayers' dollars through the Marshall plan. Sterling oil eventually, it is feared, will drive dollar oil out of even the non-sterling markets of the world. One instance of this trend is seen in the British trade pact signed late in November with Sweden. This is a barter-type agreement similar to the model of the British-Argentine agreement of a year ago, and provides that Britain will supply oil to Sweden for Swedish timber, pulp paper and iron ore.

"Such restrictive agreements have the effect of excluding American oil from these markets," one oil company official said, and many are demanding that the State Department devise some safeguards for American business operating in the sterling area.

The British restriction order virtually disrupted the Anglo-American oil talks in Washington. Victor Butler, British Undersecretary of Fuel and Power, has flown to the United States to try to give new life to the conversations. These conferences have been seeking a way by which Britain can conserve some of the $400 million she is now spending on dollar oil. The conference specified, however, that the legitimate interests of the U. S. oil companies that have long established foreign outlets should be protected.

Industry economists contend that if the dollar cost of oil produced by American companies can be reduced to the same level as that of oil from British sources, then the British should be willing to buy U. S.-produced oil. Much of Britain's oil, either dollar or sterling, comes from identical sources in the Middle East where British and American companies operate jointly. To reduce the dollar cost of their oil, the American companies would be obliged to buy much of their supplies and equipment in the soft-currency countries, reduce dollar-paid personnel, and import crude.

ECA's Attitude

The new British restrictive policy is expected to stiffen ECA's attitude on funds for foreign oil expansion. Oscar Bransky, ECA's petroleum chief, recently told a Congressional oil investigation committee that "there is a world surplus of both crude and refined products at the present time. If present currency difficulties continue there is a strong probability that the major part of the burden of any surplus which occurs will be borne by the American companies operating abroad. The continuing dollar shortage will probably prevent the return to normal competitive conditions in the foreseeable future. ECA will continue to refuse to finance projects the output of which can only be sold by restoring to discriminatory trade practices."

Bransky explained to Congress that the petroleum equipment program of ECA comprises two parts:

"The refinery expansion, drilling and maintenance program in Europe itself, and the overseas expansion programs of the companies owned by nationals of participating countries. The policy we adopted regarding the financing of overseas expansion was that we would finance such expansion only if the resulting new output was mainly needed in Europe for recovery; but not if the output was intended for export to third areas. We determined—and this is the cornerstone of our position—that we would not finance any expansion whether in Europe or overseas unless the resulting output could be sold without continued resort to currency discrimination, exclusive bilateral agreements or other such arrangements. This policy was communicated to the British whose companies were mainly engaged in the overseas expansion program. Up to the present we have not financed any part of this program."

Up to September 30 ECA has made payments for actual shipments of petroleum equipment to participating countries as follows: Belgium, $9,800; France, (including overseas territories), $2,083,000; Greece, $25,600; and Italy, $375,100, for a total of $2,493,500.

Procurement authorizations issued, for which no paid shipments had been made by September 30, were as follows: Germany Bizone, $400,000, and France, $106,000.

Project authorizations for refinery improvement and expansion, amounting to $30,370,500 are shown in an accompanying table.

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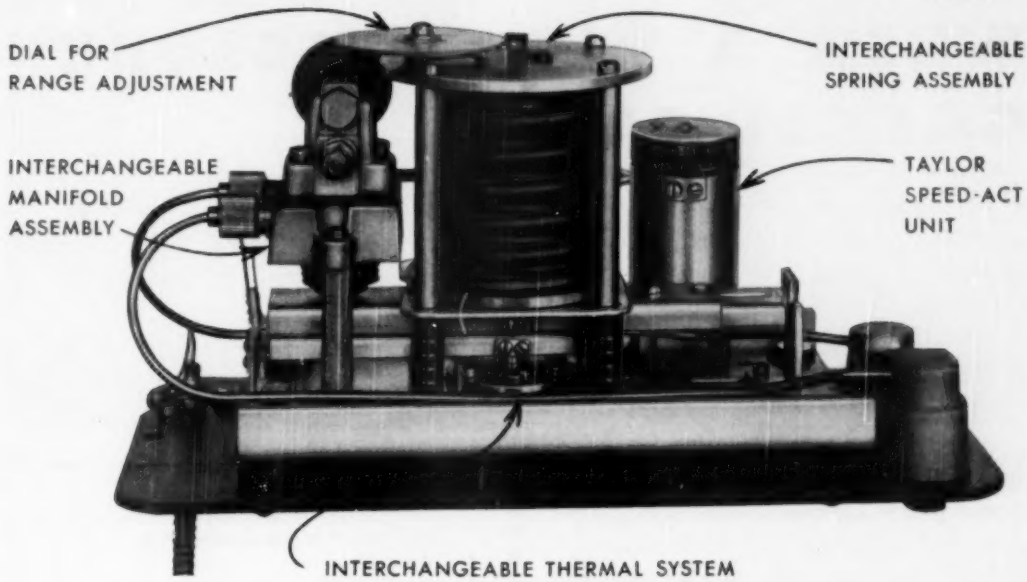

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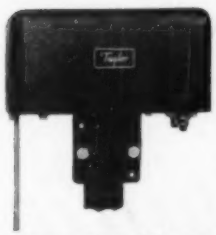

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Refinery and Other PLANT CONSTRUCTION

Petroleum Refiner's Monthly "Boxscore"

Photo above—This fluid catalytic cracking unit and its supporting installations are the heart of the modernized Gulf Oil Company refinery at Toledo, Ohio, formally opened last month on completion of a $20 million construction program. (Further details, page 102.)

Fish Engineering Contracts To Build Honolulu Refinery

A complete butane-asphalt refinery will be built in the harbor district of Honolulu, Hawaii, for Pacific Refinery, Ltd., by Fish Engineering Corporation, Houston, Ray Fish, president, has announced. The new plant, believed to cost $1.5 million, will have a normal throughput of 3000 barrels per day of charging stock, from which it will produce butane road oil, gas oil, road asphalt, and roofing asphalt. Initial production of products on an annual basis will be 70,000 to 100,000 barrels of butane, approximately 50,000 tons of asphalt, approximately 500,000 barrels of gas oil for gas plant fuel, and other products consisting of naphtha, diesel oil, etc.

Charge for the plant, which is the first refinery in the Islands, will be shipped in standard tankers and is a mixture of crude oils blended with butane. The refinery makes it possible to transport the products it will produce to the Islands in bulk shipment.

The new plant will supply a better type of fuel for the manufactured gas plant, which serves the city of Honolulu. Gas oil from the plant will be used for gas generation, replacing heavy residual oil, and will eliminate formation of troublesome tars, gums, and sulphur deposits in the distribution system. Butane produced in the plant will be distributed to all outlying areas not served by the city gas and is expected to cost about half the present level of 58 to 60 cents per gallon retail.

Design work is now underway with completion of the refinery expected early in June. Materials and equipment for the plant will be fabricated on the mainland and shipped to the Islands.

Pacific Refiners, Ltd., is an affiliate of Honolulu Gas Company, Ltd., both companies owned and operated by Hawaiian Island industrialists. Gene Englebright, executive vice-president, is in charge of both companies.

ECA Expansion Outlay Totals $31 Million

The Economic Administration so far has approved an outlay of $31.4 million from Marshall Plan funds as its share in financing a 140,000-barrel-per-day increase in European refinery capacity. The agency, as of December, had paid $2.5 million for petroleum equipment shipments from this country. Private European oil companies are putting up an additional $153.9 million to ECA's $31 million making a total outlay of $185.3 for the nine projects approved.

Puerto Rico Refinery

Progress on engineering is reported on Puerto Rican Oil Refining Company's 25,000-barrel-per-day refinery expected to be constructed next spring at Guayanilla, near Ponce, Puerto Rico. The company will not make any efforts, it says, to retail its products in the island, but will sell them to the established distributors on non-discriminatory basis.

For Box Score Tabulation see next page

New Gasoline Plant Planned for Alberta

Supreme Refineries Limited has a contract with Hanna Petroleum Company, Ltd. of Calgary, Alberta, Can., for the processing of wet gas from the Hanna Dowling well, and others in the field, located near Hanna.

The company has also contracted for the construction of a 1000-mcf. $100,000 natural gasoline plant at Hanna. A complete 1000-barrel-per-day refinery is under construction at Calgary, Alberta, Can., at an estimated cost of $100,000.

Ohio Terminal at Lima

Ohio Oil Company will complete in April a terminal at Lima, Ohio, which will receive gasoline and other products by pipe line direct from the company's Robinson, Ill., refinery. It will have a 250,000-barrel storage capacity. A similar unit will begin operation in February at Muncie, Ind. Such a unit at Indianapolis was opened in 1945.

Propane Unit Going Up At Clarkson Refinery

Scheduled for opening in May, 1950, a new propane deasphalting unit is being erected at the Clarkson, Ontario, refinery of The British American Oil Company. The $400,000 unit, when completed, will be used for the production of high quality lubricating oils in the "bright stock" classification.

Construction comprises a unit consisting of several pressure vessels, ex-

changers, condensers and coolers; furnace, pumping, compressing and control equipment, and necessary piping.

The oils to be produced by the new equipment have not previously been among the products of the Clarkson refinery. Operation of the unit will be absorbed into the refinery's over-all operations.

Plant Nears Initial Runs

Preliminary runs are expected to get under way this month at Carthage Hydrocol, Inc.'s synthetic gasoline and chemicals (from natural gas) plant at Brownsville, Texas. Construction is also near completion stages at the adjacent plants of Stanolind Oil & Gas Company which will refine and separate crude chemicals turned out by Carthage Hydrocol, Inc., and U. S. Industrial Chemicals, Inc., which will process the crude chemicals and distribute the resulting finished chemicals.

Maine Terminal Planned

An oil terminal that will accommodate 240,000-barrel super-tankers is planned for South Portland, Me., as a result of a recent merger of Pocahontas Terminal Corporation of Delaware and the California Oil Company. Storage for 300,000 to 350,000 barrels is programed. Immediate start is planned with view to having 100,000 to 125,000 barrels of fuel oil storage erected by May 1.

Research Continues As Coal-to-Gas Tests Proven

The fluidized solids technique for converting coal to gasoline has been proven, although more research is needed, Pittsburgh Consolidation Coal Company and Standard Oil Development Company said in closing their pilot plant at Library, Pa., where they have been testing the technique for 13 months. They said that rising costs of coal and its erratic supply, at the time when petroleum and natural gas are in ample supply, make it impractical to take any additional major steps toward commercialization of the coal-to-gas-to-gasoline process.

Further research will be carried out, according to the companies with the coal company probably giving more attention to natural gas synthesis. George H. Love, president of Pittsburgh Consolidation Coal Company, said that the company has been studying the possibilities of making gasoline from large available quantities of natural gas in Texas, rather than coal which supply is unreliable.

Asphalt Refinery Planned

Design plans are being prepared for an asphalt refinery to be built at Point Wells, Wash., by Stancal Asphalt & Bitumuls Company, a subsidiary of Standard Oil Company of California. Included will be a modern vacuum distillation unit, office building, insulated storage tanks, and complete truck and rail loading facilities. Mid-1950 is the set completion date.

Crude oil for operation will be brought by tanker from California.

Sohio Contract to Bechtel

The Standard Oil Company (Ohio) present Houdry fixed-bed catalytic cracking unit at Cleveland No. 1 refinery will be converted to a moving-bed Thermofor catalytic cracking unit, designed by Socony Vacuum Oil Company, licensor. Mechanical engineering design and construction for the conversion has been let to Bechtel Corporation. When completed, (November 1, 1950 is scheduled), the unit will be the same type as Magnolia Petroleum Company is installing at its Beaumont refinery.

Rebuilding Docks

An extensive rebuilding program to enable two of the largest tankers afloat to dock and load with crude oil at the same time is underway at Humble Pipe Line Company's Harbor Island terminal on the Corpus Christi ship channel. Both of the terminal's present wooden wharves will be torn down and replaced with larger steel wharves.

The new wharves, large enough to enable two 720-foot tankers to dock and load simultaneously, will be 300 feet long and 27 feet wide. A new barge slip will be 100 feet wide by 390 feet long.

REFINERY AND OTHER PLANT CONSTRUCTION

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
California Refg. Co.	Perth Amboy, N.J.	Houdriflow Cat. Crk.	25,000		Engineering		Houdry	Houdry, Braun	Braun
E. I. Dupont	Parkersburg, W. Va.	Tetrafluorurethylene Resin Plant			Under Constr.	Summer, 1950			
Esso Standard Oil	Bayonne, N.J.	MEK Dewaxing	7,500 bbls.		Under Constr.	Jan., 1950	Texaco	Badger	Badger
Esso Standard Oil	Bayonne, N.J.	Steam Boilers	400,000 lbs. hr.		Under Constr.	2nd Qtr., 1950		S.O.D., Day & Zimmerman	S.O.D. & Zimmerman
Freedom-Valvoline Oil Co.	Freedom, Pa.	Filter Plant	800 bbls.		Under Constr.	Late, 1949			
Freeport Sulphur Co.	Westville, N.J.	Sulfur Recovery	40 tons		Contracted				Girdler
The Pure Oil Co.	Savannah, Ga.	Lube Bld. Pkg.			Under Constr.	1949			
Quaker State Oil Refining Corp.	Emlenton, Pa.	Boiler Plant Add.	65,000 lbs. hr.	$160,000	Under Constr.	Jan., 1950			Staff
Socony-Vacuum Oil Co.	Paulsboro, N.J.	Propane Deasph.	5,950 bbls.		Under Constr.	Dec., 1949	Juik	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	MEK Dewaxing	2,050 bbls.		Under Constr.	1st Qtr., 1950	Texaco	Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Light Oil Trtng.	28,000 bbls.		Designing	Dec., 1949		Badger	Badger
Socony-Vacuum	Paulsboro, N.J.	Mod. Comp. Pkg. Dept.	5,000 bbls.		Under Constr.	Jan., 1950		Staff	Staff
J. Sonneborn Sons	Petrolia, Pa.	Antipollution		$400,000	Under Constr.	1st Qtr., 1950		Chemico	Knowles
The Texas Co.	Beacon, N.Y.	Expand Research Labs.			Completed			Voorhees, Walker, Foley & Smith	
The Texas Co.	Westville, N.J.	New Refinery	40,000 bbls.		Completed			Foster Wheeler, Jackson-Moreland, Kellogg	Foster Wheeler, Kellogg
United Refining Co.	Warren, Pa.	Lab. Steam Gen.	60,000 lbs. hr.			4th Qtr., 1950			Union Iron Wks.
MID-CONTINENT									
Champlin Refining Co.	Enid, Okla.	Crude Unit	18,000 bbls.	$600,000	Completed			Koch	Staff
Champlin Refining	Enid, Okla.	Cat. Poly Unit	450 bbls.	$200,000	Completed		U.O.P.	Koch	Staff
Cities Service, Del.	Cleveo, Ill.	Compound Plt.	1,200 bbls.	$4 million	Contracted	July, 1950			Sollitt
Columbian Fuel Corp.	Hickok, Kans.	Desulfurization	2,000 mcf	$15,000	Under Constr.	Dec., 1949		Graff	Graff
Consolidated Gas Utilities Corp.	Cement, Okla.	Compr. Sta.	40,000 mcf		Under Constr.	Jan. 1, 1950		Dresser	Dresser
Deep Rock Oil Corp.	Cushing, Okla.	Cat. Cracker	5,000 bbls.		Under Constr. Planning	Spring, 1950		U.O.P.	J. & L. Constr.
The Derby Oil Co.	Wichita, Kans.	Cat. Crk. Change		$15,000	Under Constr.	Spring, 1950		Staff	Staff
Dewese Oil Co.	Weston, Ohio	Lube Filtering	250 bbls.	$1.5 million	Under Constr.	Jan., 1950		Staff	Prichard, Mahoney
The Dow Chem Co.	Midland, Mich.	Comp. Sta. & Pipeline	5,000 mcf gas		Completed			Rust Pro.	Rust Pro.
Ethyl Corp.	Ferndale, Mich.	Batch Gasoline Distil. Units	1 to 3 bbls.						
Globe Oil & Ref. Co.	Lemont, Ill.	Cat. Cracker	6,000 bbls.	$1 million	Under Constr.	Jan., 1950	U.O.P.	U.O.P.	
Gulf Oil Corp.	Kiefer, Okla.	Gaso. Plant	14,500 mcf		Under Constr.				
Indiana Farm Bureau Cooperative Assn.	Mt. Vernon, Ind.	Fluid Cat. Cracking Unit	4,000 bbls.		Under Constr.	1951		U.O.P.	Staff
Lever Bros. Co.	Hammond, Ind.	Hygrited Plant	150,000 elf		Under Constr.	Jan., 1950		Staff	Girdler
Magnolia Pet. Co.	Grant County, Kans. (Hickok)	Gasoline Plant	100,000 mcf		Under Constr.	Jan., 1950		Staff, Waleo	Waleo
Magnolia Pet.	Chitwood, Okla.	Pressure Maint. & Cycling	24,750 mcf		Under Constr.	Dec., 1949		Staff, Constr. Service	Constr. Service
Magnolia Pet.	Stephens County, Okla.	Gasoline Plant	20,000 mcf		Under Constr.	Jan., 1950		Staff, J. & L. Constr.	J. & L. Constr.
Midland Cooperative Wholesale	Cushing, Okla.	Cat. Poly Unit	200 bbls.		Authorized	Early 1950			Ref. Eng. U.O.P.

■ CONTINUED ON PAGE 79

Figure it at

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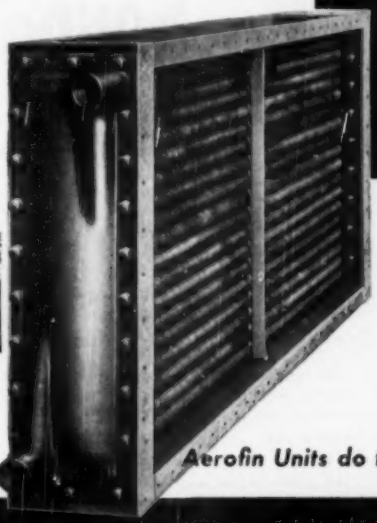

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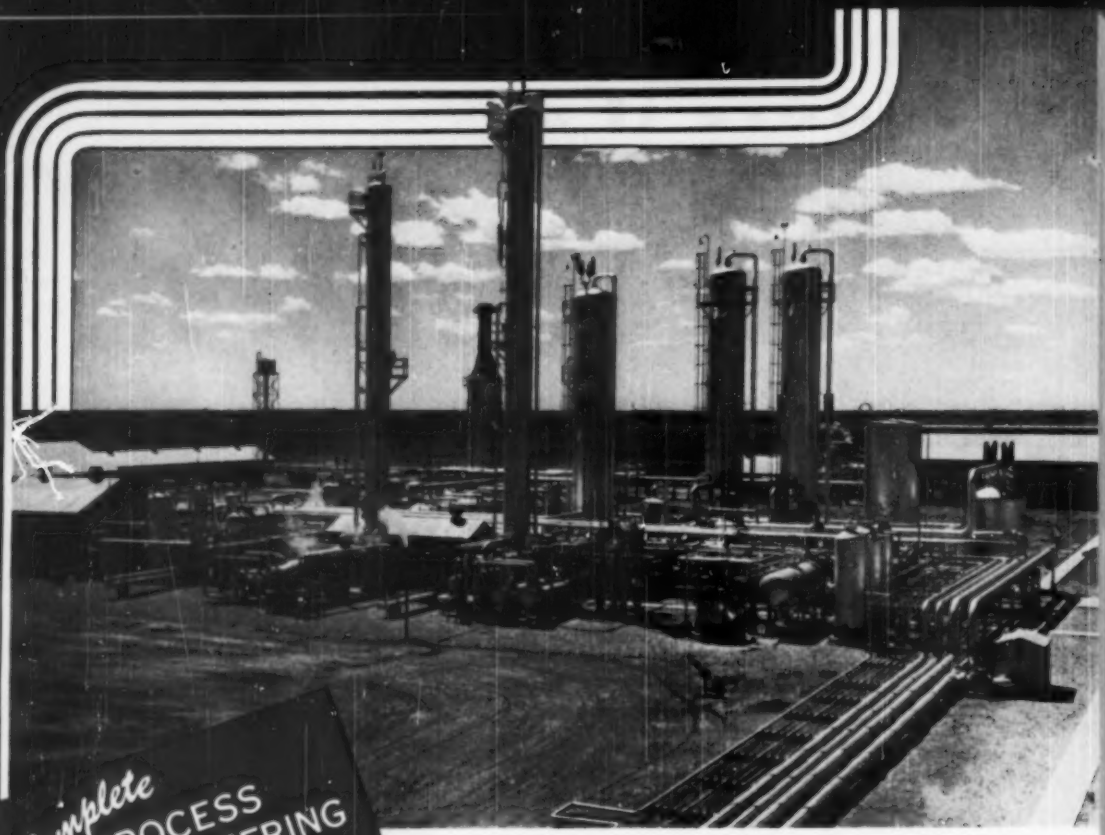

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REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Mississippi River Fuel Co.	Star City, Ark.	Comp. Sta.	5,000 hp.		Under Constr.	Feb., 1950		Ref. Maint.	Ref. Maint.
Mississippi River	Pocahontas, Ark.	Comp. Sta.	5,000 hp.		Under Constr.	Feb., 1950		Ref. Maint.	Ref. Maint.
Mississippi River	Fredericktown, Ark.	Comp. Sta.	4,000 hp.		Under Constr.	Feb., 1950		Ref. Maint.	Ref. Maint.
National Co-Op. Refinery Assn.	McPherson, Kans.	Polymerization	450 bbls.	$430,000	Planning		U.O.P.		
Northern Nat. Gas Co.	Clifton, Kans.	Compress. Add.	1,600 hp.		Under Constr.	1949			Fluor
Northern Nat. Gas	Mullinville, Kans.	Inc. Comp. Cap.	3,200 hp.		Under Constr.	1949			Dresser
Northern Nat. Gas	Sublette, Kans.	Gasoline Plant	203,000 mcf		Authorized	1950			Pritchard
Northern Nat. Gas	Sublette, Kans.	Increase Comp.	3,200 hp.		Under Constr.	1949			Fluor
Northwestern Refining Co.	St. Paul Park, Minn.	Loading Rack, Products Transfers Line	500,000 gals.	$40,000	Under Constr.	Jan., 1950		Staff	Staff
*The Ohio Oil Co.	Muncie, Ind.	Ref. Products Terms.	100,000 gals.		Under Constr.			Staff	Michael-Poling
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	200 Bbls	$40,000		4th Qtr., 1949			
Osceola Refining Co., Inc.	Reed City, Mich.	Desalting Unit	2,000 bbls.	$10,000	Authorized	1st Qtr., 1950	Petreco	Petreco	Staff
Pan-Am Southern Corp.	El Dorado, Ark.	Delayed Coke Water Cooling Tower, Steam Gen. Boiler, Coke & Loading	9,300 bbls.		Planning	Sept., 1950		Lummus	Lummus
Petco Corp.	Blue Island, Ill.	Houdry, Cat. Crk., LPG Recov.	5,000 bbls.	$400,000	Under Constr.	4th Qtr., 1949	Houdry	Houdry	Clarke
Petroleum Specialties, Inc.	Flat Rock, Mich.	Cat. Cracker	3,000 bbls.	$2 million	Planning				
Phillips Pet. Co.	Kansas City, Mo.	Cat. Cracker	24,000 bbls.	$10 million	Under Constr.	Dec., 1949		Braun	Brown
Phillips Pet., et al	Edmond, Okla.	Absorp. Plt. Add.	60,000 mcf		Authorized	Mar., 1950			Ref. Maint.
The Pure Oil Co.	Toledo, Ohio	Revamp. Crd. Reform.			Under Constr.	1949			Cat. Constr.
The Shallow Water Refining Co.	Shallow Water, Kansas	Reforming Unit	1,250 bbls.	$a5,000	Under Constr.	April, 1950	Perco	Koch Eng.	Koch Eng.
Shelly Oil Co.	El Dorado, Kans.	Crd. Dist. Cat. Crk.	135,000 bbls.	$8-10 million	Under Constr.	Mid 1950			
Socony-Vacuum Oil Co.	E. St. Louis, Ill.	Thermal Crack.	13,200 bbls.		Under Constr.	Jan., 1950		Staff	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Miscel. Ref. Adds.			Under Constr.	Jan., 1950		Staff, Bechtel	Bechtel
Socony-Vacuum	E. St. Louis, Ill.	Delayed Coking	8,700 bbls.		Under Constr.	March, 1950		Staff, Bechtel	Bechtel
Socony-Vacuum	Augusta, Kans.	Houdry Conversion to T.C.C.	15,000 bbls.		Planned	Mid. 1950	Socony-Vacuum		
Socony-Vacuum	Trenton, Mich.	Houdry Conversion to T.C.C.	15,000 bbls.		Planned	Mid. 1950	Socony-Vacuum		
Standard Oil Co., (Indiana)	Whiting, Ind.	Outside Battery Limit Facilities			Under Constr.	1949		Fluor	Fluor
Standard Oil Co., (Ohio)	Cleveland, Ohio	Houdry Cat. Change		$450,000	Under Constr.	Jan., 1950			
Standard (Ohio)	Cleveland, Ohio	Cat. Crk. Expansion	8,000 bbls.			Jan., 1951			
Standard (Ohio)	Lima, Ohio	Inc. Tank. Cap.	384,000 bbls.	$240,000	Under Constr.	May 1, 1950		Staff	Hammond
Standard (Ohio)	Lima, Ohio	Liquid Gas Plt.		$220,000	Under Constr.	1949		Staff	Undetermined
Standard (Ohio)	Lima, Ohio	Furfural Refg.	76,000 gals.	$13 million	Contracted	1951	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Crd. Dist. Coke	115,000 bbls.	$5.5 million	Under Constr.	Feb., 1950	Kellogg	Kellogg	Kellogg
Standard (Ohio)	Lima, Ohio	Solvent Dewax.	1,800 bbls.		Under Constr.	Feb., 1950	Kellogg	Kellogg	Kellogg
Standard (Ohio)	Lima, Ohio	Solvent Dewax.	1,800 bbls.		Under Constr.	Mid. 1950	Texaco	Lummus	Lummus
Standard (Ohio)	Lima, Ohio	Vacuum Unit	9,000 bbls.		Under Constr.	Mid. 1950			Lummus
Standard (Ohio)	Lima, Ohio	Propane Deasph.	800 bbls.		Under Constr.	Mid. 1950			Kellogg
Sun Oil Co.	Toledo, Ohio	Cat. Crack., Crude Dist., Vac., Poly	30,000 bbls.	$30 million	Under Constr.	March, 1950	Houdry	Houdry, Cat. Constr., Process Eng., Staff	Cat. Constr.
Sun Oil	Toledo, Ohio	Compressor Sta.	3,840 hp.		Under Constr.			Fluor	
The Texas Co.	W. Tulsa, Okla.	Ex. Mod. Ref.	30,000 bbls.	$15 million	Completed			Kellogg, Foster Wheeler, U.O.P.	Kellogg, Foster Wheeler
The Texas Co.	Lawrenceville, Ill.	Expand Refinery	120,000 bbls.		Under Constr.	April 1, 1951		Foster Wheeler, Kellogg	Foster Wheeler, Kellogg
Tide Water Associated Oil Co.	Drumright, Okla.	Houdriflow Unit Cat. Cracker	4,500 bbls.		Under Constr.	Jan. 15, 1950	Houdry		Process Eng.
U.S. Dept. of Interior	Louisiana, Mo.	Demonstration oil-from-coal	80 bbls.	$5 million	Under Constr.	Feb., 1950		Koppers	Koppers
Vickers Petroleum Co., Inc.	Potwin, Kans.	Thermal Poly Unit	250 bbls.	$100,000	Authorized	Feb., 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Wood River Oil & Refining Co., Inc.	Hartford, Ill.	Fluid Cat. Cracker	7,500 bbls.	$7.5 million	Under Constr.	Jan., 1950	U.O.P.	Koch	Staff
Wood River Oil R.	Hartford, Ill.	Vacuum Unit	15,000 bbls.	$700,000	Completed			Koch	Staff
SOUTHWEST									
Ada Oil Co.	Houston, Texas	Loading Sta.			Under Constr.	1949		Rollco	
Alba Refg. Co.	Alba, Texas	Asphalt Refining	1,500 bbls.	$125,000	Under Constr.	1949			
Calumet Refg. Co.	Princeton, La.	Blending Oil Tank House	700 bbls.		Under Constr.	1st Qtr., 1950		Staff	Staff
Carthage Hydrocol, Inc.	Brownsville, Texas	Hydrocol	87,000 mcf	$26 million	Under Constr.	Feb., 1950	Hydro-Res., Inc. Texaco	McKee, Hydro-Res., Inc.	McKee
Cities Service Oil	Chico Field, Tex.	Natl. Gaso. Plt.	22,000 mcf		Designing	Early 1950		Fluor	Fluor
Cities Service Oil	St. Rose, La.	Lube Oil Blending	4,000 bbls.	$750,000	Under Constr.	Late 1949		Day & Zimmerman	Day & Zimmerman
Coastal Refineries, Inc. & Mayfair Minerals, Inc.	McAllen, Texas	Cycling Plant	75,000 mcf		Under Constr.	Mar., 1950		Gaso. Plant	Gaso. Plant
Continental Oil Co.	McAllen, Texas	Add Gaso. Plt.	20,000 mcf	$1.5 million	Under Constr.	Feb., 1950			J. & L. Constr.
Continental Assocs.	Near Nordheim, DeWitt County, Texas	Gas Comp.	12,000 mcf	$1 million	Under Constr.	Jan., 1950	None	Process Eng.	Process Eng.
Del Rey Petroleum Co.	Chesterville, Tex.	Pressure Absorption Plant	25,000 mcf		Under Constr.			O. L. Olson	Ole Olson
Department of the Army	Houston, Texas	Anhydrous Ammonia Facility	2,100 tons monthly	$2.5 million	Relocating	4th Qtr., 1949		Girdler Corp.	Hercules Powder Co.
Dow Chemical Co.	Freeport, Texas	Ammonia Plant	100 tons	$5 million	Planning	Late 1950			
Dow Chemical	Freeport, Texas	Chlorine Addition			Under Constr.	Late 1949		Staff	Tellepsen
El Paso Natural Gas Co.	Mohana Field, Texas	Gasoline Plant	16,700 mcf		Under Constr.	Dec., 1949		Fluor	Fluor
El Paso Natural Gas	Mohana Field	Treating Plant			Under Constr.	Dec., 1949		Fluor	Fluor
El Paso Natural Gas.	Moore County, Texas	Compressors	10,600 hp.	$1.8 million	Under Constr.	Jan., 1950		Staff	

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
El Paso Natural Gas.	Moore County, Texas	Gas Dehydration Addn.	130,000 mcf	$55,000	Under Constr.	Jan., 1950		Stearns Roger	Staff
El Paso Natural Gas.	Castro County, Texas	Compressor Sta.	4,050 hp.	$1.1 million	Under Constr.	Jan., 1950		Staff	Staff
El Paso Natural Gas.	Crane County, Texas	Compressor Sta.	4,400 hp.	$1.27 million	Under Constr.	Jan., 1950		Staff	Staff
El Paso Natural Gas.	Ector County, Texas	Compr. Unit	3,300 hp.	$850,000	Under Constr.	Jan., 1950		Staff	Staff
E. I. DuPont de Nemours Co., Inc.	Victoria, Texas	Chemical Intermediate for Nylon			Design	Early 1951		Staff	Staff
Esso Standard Oil Co.	Baton Rouge, La.	Main Office, Cafeteria, Crude Distilling Unit				May, 1950		Bodman & Murell, Staff	Staff
Ethyl Corp.	Baton Rouge, La.	Mfg. Facilities		$40 million	Completed			Stone & Webster	Stone & Webster
Evangeline Refining Co.	Jennings, La.	Perco Cyclerversion	400 bbls.		Under Constr.	4th Qtr., 1949		Grebe & Doremus	Mason
Humble O&R Co.	Katy, Texas	Add Propane, Absorp., Refrig.	Unchanged		Under Constr.	Jan., 1950		Stearns-Roger	Stearns-Roger
Humble O&R.	Baytown, Texas	Roof Replacing of Butyl Bldg.			Under Constr.	Feb., 1950		Staff	Tellepsen
Humble O&R.	Baytown, Texas	Mucl. Facilities		$1 million	Projected				Hudson
Humble O&R.	Jourdanton Field, Texas	Gasoline Plant	36,000 mcf		Under Constr.	Early 1950			
Humble O&R.	Baytown, Texas	Research Bldg.			Under Constr.	Aug., 1950		Voorhees-Walker	Knutson
Humble O&R.	Baytown, Texas	Mech. Maint. Bldg.			Under Constr.	Oct., 1950		Ferguson	Bellows
Lone Star Gas Co.	Dallas, Texas	Hypernorytion	60 mcf		Postponed		Union Oil Co.	Foster Wheeler	Foster Wheeler
Magnolia Pet. Co.	Beaumont, Tex.	Two Houdry's to T.C.C.	30,000 bbls.		Authorized	Late 1950			Lummus
Magnolia Pet.	Seeligson Field, Premont, Texas	Gasoline Cycling	150,000 mcf Cycled		Under Constr.	1949		Hudson	Hudson
Magnolia Pet. (Operator) et al.	Lolita-La Ward, Jackson County Texas	Comp. Sta.	15,000 mcf		Under Constr.	Feb., 1950		West	West
Mathieson Chem Co.	Pasadena, Texas	Fertilizer Fls.			Under Constr.	1950		Owner	
Mayfair Minerals	McAllen, Texas	Cycling Plant	30,000 mcf		Under Constr.	Mar., 1950		Gasc. Plant	Gasc. Plant
*McMurray Refining Co.	Tyler, Texas	Fluid Cat Cracker, Gas-Concentration, Feed Prep. & Cycle-Oil Crack.	5,000 bbls.		Planned	Fall, 1950		U.O.P.	U.O.P.
Midland Gasoline Co.	Conroe, Texas	Enlarge Gasoline	100,000 gals.		Under Constr.	Dec., 1949		Gasc. Plant	Gasc. Plant
Northern Nat. Gas Co.	White Deer, Texas	2 Comp. Stns.	60 hp., 900 hp.			Dec., 1949		Staff	Dresser
Pan American Refining Corp.	Texas City, Tex.	Revamping Crude Unit			Completed			Tellepsen	Tellepsen
Pan Am. Ref.	Texas City, Tex.	Desulfo Unit		$35,000	Under Constr.	Early 1950		Tellepsen	Tellepsen
Pan Am. Ref.	Texas City, Tex.	Lab., Pilot Plt.			Under Constr.	Spring, 1950		Ferguson	Ferguson
Panhandle Producing & Refining Co.	Wichita Falls, Texas	Cat. Cracker	1,500 bbls.	$1 million	Under Constr.	Jan., 1950	U.O.P.	U.O.P., J. & L.	J. & L. Constr.
Phillips Chemical Co.,	Etter, Texas	Prod. of Nitric Acid	225 tons		Under Constr.	1949	Chemico	Chemico	Brown & Root
Phillips Chemical	Etter, Texas	Fertilizer Plant	300 tons		Under Constr.	4th Qtr., 1949	Chemico	Chemico	Brown & Root
Phillips Chemical	Borger, Texas	Increase Cap. Phil-black Carbon Black Plt.	8 mln. lbs. yr.		Under Constr.	Dec., 1949		Staff	
Phillips Chemical	Etter, Texas	Inc. Cap. Cactus Ammonia Plant	440 tons	$5.3 million	Under Constr.	4th Qtr., 1949	Chemico	Chemico	Brown & Root
Plymouth Oil Co.	Rankin, Texas	Gas Compression, Absorp.	70,000 mcf	$5½ million	Under Constr.	1949-50			Hudson
The Pure Oil Co.	Dellarhid, Andrews County, Texas	Nat. Gasoline Plant	22,000 mcf	$6 million	Under Constr.	July, 1950			
The Pure Oil Co.	Nederland, Tex.	Barge Dock Repair			Under Constr.	Late 1949		Staff	Tellepsen
The Pure Oil Co.	Nederland, Tex.	Wax Plt. Add.			Under Constr.	Early 1950		Staff	Tellepsen
The Pure Oil Co.	Nederland, Tex.	Wax Fractnin.	200 bbls.		Under Constr.	4th Qtr., 1949	Texaco	Lummus	Lummus
Reno Oil Co.	Holiday, Texas	Gasc. Press. Maint. Plant	400 hp.		Under Constr.	4th Qtr., 1949	None	O. L. Olson	O. L. Olson
The Shamrock Oil & Gas Corp.	Sunray, Texas	Inc. Top., Crk.	10,000 bbls.	$300,000	Under Constr.	4th Qtr., 1949	U.O.P.	Staff	Staff
The Shamrock Oil & Gas	Sunray, Texas	Cyclorversion Unit	1,500 bbls.	$300,000	Under Constr.	Early 1950	Perco	Staff	Staff
Shell Oil Co.	Houston, Texas	Lube Utilities			Under Constr.	1949		Fluor	
Shell Oil Co.	Provident City, Texas	Gas Stripping	60,000 mcf		Under Constr.	1st Qtr., 1950		Fluor	Fluor
Shell Oil Co.	Notrees, Texas	Add TXL Plant	30,000 mcf		Under Constr.	Early 1950		Brown & Root	Brown & Root
Shell Oil Co.	Denver City, Texas	Gas Comp. Absorp. Add.	30,000 mcf		Under Constr.	Late 1949		Fluor	Fluor
Southern Minerals Corp.	Stratton Field, Texas	Gas Compression Addition			Under Constr.				
Standard Oil & Gas Co., Opr.	Fullerton Field, Texas	Gasoline Plant	55,000 mcf		Under Constr.	Jan., 1950		J. & L. Constr.	J. & L. Constr.
Standard Oil & Gas Co.	Alvin, Texas	Dehydration, Gas Sales Plt.			Under Constr.	Dec., 1949		Staff	Tellepsen
Standard Oil	Brownsville, Tex.	Chemical Plant	150 tons		Under Constr.	Jan., 1950		Badger	Badger
Standard Oil	Levelland, Tex.	Gasoline Plant	60,000 mcf		Under Constr.	Feb., 1950		Brown & Root	Brown & Root
Standard Oil	N. Cowden, Tex.	Gasoline Plant	50,000 mcf		Under Constr.	1950		Stearns-Roger	Stearns-Roger
Tex. Natl. Gas Corp. & Slick-Urschel	Rankin, Texas	Nat. Gasoline Plant	55,000 mcf		Completed			Tex. Natl. Gas Corp.	Pritchard J
Texas Nat. Gasc. Corp. & Slick-Moorman Oil Co.	Grandfalls, Pecos County Texas	Nat. Gasc. Plt.	30,000 mcf		Under Constr.	Jan., 1950		TNGC Staff	TNGC Staff
The Texas Co.	Tijerina-Canales Field, Texas	Gas Compression	5,000 mcf		Under Constr.	July, 1950			
United Gas Pipe Line Co.	Karnes City, Texas	Nat. Gas, Condensate Process	10,000 mcf	$1 million	Under Constr.	Jan., 1950		Delta	Delta
ROCKY MOUNTAIN									
Coronado Gas Corp.	Lusu Hills Field, N. M.	Repressuring, Extraction	10,000 mcf	$500,000	Under Constr.	Dec., 1949	Pet. Eng.	Pet. Eng.	Pet. Eng.
El Paso Nat. Gas Co	Lea County, N. M.	Compressor Sta.	5,500 hp.	$1.35 million	Under Constr.	Jan., 1950		Staff	Staff
El Paso Nat. Gas		Gas Purif. Plt.	30,000 mcf	$325,000	Under Constr.	Jan., 1950		Stearns-Roger	Staff
El Paso Nat. Gas		Gasc. Absp. Plt.	50,000 mcf	$285,000	Under Constr.	Jan., 1950		Stearns-Roger	Staff
Frontier Refining Co.	Cheyenne, Wyo.	Coking, 2 Coke Crks.	2,000 bbls.	$725,000	Contracted	May, 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Northern Natural Gas Co.	Palmyra, Neb.	Compressor Add.	1,600 hp.		Under Constr.	1949	-		Fluor

• CONTINUED ON PAGE 83

COPPER ALLOY BULLETIN

CONDENSER AND HEAT EXCHANGER TUBING EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

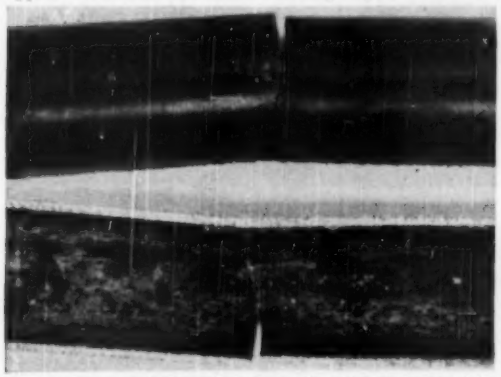
Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

CRACKING OF CONDENSER TUBES

Influenced by Excessive Vibration

Sometimes examination of leaking condenser tubes shows that they have failed from transverse cracks close to the tube sheet or midway between tube supports. Closer examination frequently reveals the presence of abrasion marks on the outside of the tubes, about midway between tube supports. Sometimes deep abrasion marks will be found in that section of the tube in contact with the support sheet. Those tubes which face the incoming stream may show some roughening of their outside surface. When water, or petroleum products containing brine are carried inside the tubes, examination of the interior reveals, after removal of corrosion products, a few, up to several hundred, fine transverse cracks which have not perforated the tube. Deep, hemispherical corrosion pits may also be found in the affected area.

Microscopic examination discloses that the cracks have the appearance of a brittle fracture, showing very little reduction



Corrosion fatigue crack viewed from the outside and inside surface of the same condenser tube.

of cross-sectional area. If corrosion is not far advanced, the fracture may be very bright and coarsely crystalline. Careful laboratory examination of such tubes and study of operating data have shown that these are the symptoms of cracking resulting from excessive vibration of the condenser tube.

Fatigue Cracking Through Vibration. It has been established that when a tube is repeatedly flexed back and forth with sufficient severity for a long period of time, it will fail from fatigue cracking. The combined action of corrosion and vibration leads to more rapid development of cracks in condenser tubes.

The effect of corrosion in accelerating fatigue cracking of tubing is apparently due to roughening of the surface. A roughened surface is often more subject to lowered fatigue life than a smooth surface. The flexing back and forth of vibrating tubes presumably injures the protective film and, at the points where this occurs, cracking develops. It has been observed that deep, hemispherically-shaped corrosion pits also develop in this area to a greater extent than elsewhere on the tube surface. For example, at the points of least vibration, this type of pitting is scarcely discernible.

Corrosion fatigue cracking is generally confined only to a relatively small number of tubes in a condenser or heat exchanger, because only a few tubes in the unit may be responsive to the type of vibration present.

Corrosion fatigue cracking is most prevalent where corrosive waters are encountered such as in plants using harbor waters polluted by various types of wastes. In plants using clean, fresh water relatively little trouble from corrosion-fatigue has been called to our attention.

Sources of Vibration. Pulsating streams of liquids or gases striking the tubes at high velocities frequently start tubes vibrating. Sometimes vibration of compressors, pumps, and adjacent equipment may start some of the tubes vibrating. Where the pulsation is the same as the resonant frequency of the tubes, the extent of vibration developed in the tubes is surprisingly great and is the primary cause of this type of failure.

Preventing Excessive Vibration. Condenser designers have come a long way toward keeping this type of difficulty to a minimum. In some old installations, excessive vibration has been greatly reduced by using more tube support sheets. Where that may not be practical, good results have been obtained by wedging pieces of flattened tubing between the rows of tubes affected. In other cases, vibration has been reduced by making sure that all equipment is running smoothly, and by avoiding critical operating speeds of turbines, pumps, compressors, and motors.

Choosing the Best Alloy. Operating conditions are becoming more complicated and severe. While Admiralty gives excellent service under many conditions, the possibilities of other alloys, such as Arsenical Muntz, Aluminum Brass, Cupro Nickel, Red Brass, Copper and combinations of these metals with steel, and stainless aluminum, etc., in the form of Duplex Tubing, should be considered.

Contact the nearest Bridgeport office for service, and write for the 120-page Condenser Tube Manual, containing many helpful facts concerning condenser tube applications in various industries, as well as data on condenser tube alloys, corrosion, methods of installing, specifications and other usual facts.

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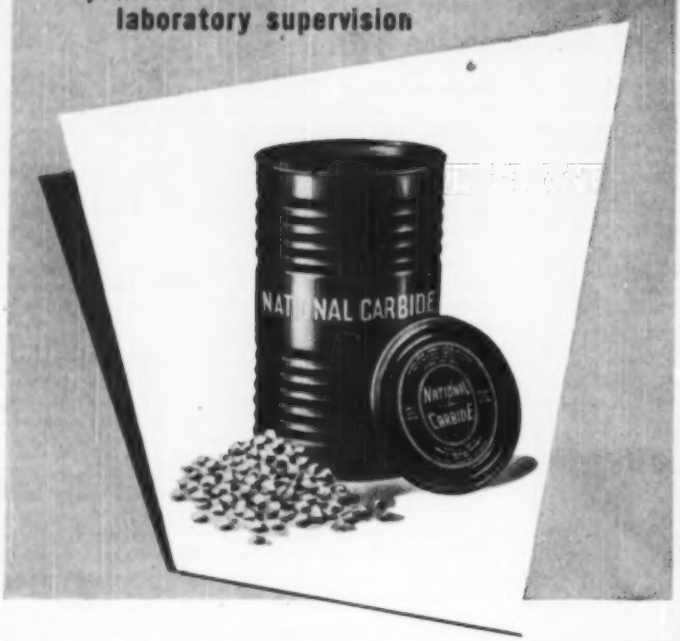
For high acetylene yield . . . specify National Carbide

produced under laboratory supervision



Rigidly controlled and tested during manufacture . . . and produced from the finest lime and coke available, "*National Carbide*" (meeting all Federal Specifications) assures every customer an exceptionally high acetylene yield per pound of carbide — a minimum 4½ cu. ft. This high quality, plus careful adherence to a special packaging technique accounts for "*National's*" wide acceptance as the Carbide producing maximum acetylene production . . . at lowest operating cost.

Also, and of vital importance to you, no matter where your plant is located, "*National Carbide*" can be obtained in any quantity from a nearby Airco office, authorized dealer, or warehouse.

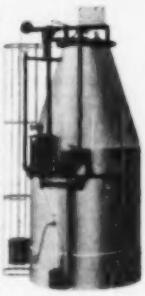
For more information about this top-grade product, write your name and address on the margin below, and send it to your nearest Airco office or authorized dealer for a copy of Catalog 30.

* * *

Air Reduction supplies Oxygen, Acetylene and other industrial gases . . . Carbide . . . and a complete line of gas cutting machines, gas welding apparatus and supplies, plus arc welders, electrodes and accessories. Ask us about anything pertaining to gas welding and cutting, and arc welding . . . we'll be glad to help you.

More news about AIRCO products

STATIONARY ACETYLENE GENERATORS



Airco's 300 pound (double rated — 600 cu. ft. per hr.) and 500 pound (double rated — 1,000 cu. ft. per hr.) stationary acetylene generators are suitable for operating all types of welding or cutting torches.

Automatic in principle, these generators feature hot galvanized shells — inside and out, with all welded seams. Operating parts have been reduced to a minimum — and are easily accessible for inspection or repair.

Also included as standard equipment are "protectomator filters" to entrap suspended lime, and prevent clogging acetylene pipe lines, regulators and torches.

PORTABLE ACETYLENE GENERATORS

The Airco Type "P" portable acetylene generator is designed and constructed for efficiency, convenience, dependable and low-cost operation . . . and requires little attention other than draining and refilling with carbide and fresh water. Other features include:

- **Quick, easy charging**
- **"Air Lift" principle of water circulation**
- **Glass viewing window in carbide hopper**
- **Simple and conveniently located controls**
- **Large-size sludge agitator and valve for complete and fast sludge removal.**

Made in three sizes, each approved for double-rated operation: 15-lb. size, 30 cu. ft. per hr.; 30-lb. size, 60 cu. ft. per hr.; and 50-lb. size, 100 cu. ft. per hr.

All Airco generators conform with the specifications of Underwriters' Laboratories and Factory Mutual.

MAGNOLIA AIRCO GAS PRODUCTS CO.

Houston • Beaumont • Corpus Christi • Wichita Falls
El Paso • Fort Worth • San Antonio • Dallas

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
The Pure Oil Co.	Worland, Wyo.	Gasoline Plant	.....	.....	Projected	.....	.....	.....	.....
Salt Lake Refining Co.	Salt Lake City	Cat. Cracking	25,000 bbls.	$10 million	Design	Jan., 1951	Houdry	Bechtel-Houdry	Bechtel
Sioux Oil Co.	Newcastle, Wyo.	Thermal Crk.	1,300 bbls.	$300,000	Authorized	Early 1950	U.O.P.	Koch	Staff
Sweeny-Vacuum Oil Co.	Draper, Wyo.	Topp. Revisions	5,000 bbls.	.....	Under Constr.	Fall, 1949	.....	Staff	Cot. Constr.
Standard Oil & Gas Co.	Eunice, N.M.	Storage Loading Rack	8,000 bbls.	.....	Under Constr.	Dec., 1949	.....	Staff	Drumer
Texas Gulf Sulfur Co.	Worland, Wyo.	Sulfur Recov., Gas Treat. Plts.	30,000 mcf	.....	Under Constr.	.....	.....	Girdler, C. F. Braun, Foster Wheeler	Girdler
WEST COAST									
Continental Oil Co.	Ventura, Calif.	Rev. to Gaso. Plt.	20,000 mcf	.....	Under Constr.	May, 1950	.....	Ref. Maint.	Ref. Maint.
Coline Gasoline Co.	Ventura, Calif.	Rev. to Gaso. Plt.	20,000 mcf.	.....	Under Constr.	Jan., 1950	.....	Ref. Maint.	Ref. Maint.
General Pet. Corp.	Torrance, Calif.	H_2S Absorption	.....	.....	Engineering	Jan., 1950	.....	Badger	Badger
General Pet.	Torrance, Calif.	Chemical Treat.	2,000 tons	Completed	.....	.....	.....	Staff	Staff
General Pet.	Torrance, Calif.	Two Coke Drums, Furnace	7,500 bbls.	$2.25 million	Under Constr.	Early 1950	.....	Kellogg, Staff	Bechtel
Hancock Chemical Co.	Long Beach, Cal.	H_2S Recovery	80 tons	$1 million	Designing	Jan., 1950	.....	Badger	Badger
Hancock Oil Co.	Long Beach	Ethylene Glycol	60,000 lbs.	.....	Engineering	3rd Qtr., 1950	.....	Badger	Badger
Ohio Oil Co.	S. Coles, Leves, Calif.	Gas Lift	1,600 hp.	.....	Completed	.....	.....	Fluor	Fluor
Paloma Refining Co.	Paloma Field, Calif.	Extend Absorption Sect.	60,000 mcf	.....	Planning	.....	.....	.....	.....
Richfield Oil Corp.	Cuyama, Calif.	Absorption H_2S Removal	15,000 mcf	.....	Under Constr.	1949	.....	Fluor	Fluor
Richfield Oil Corp.	Cuyama, Calif.	Comp. Plt. Extn.	2,640 hp.	.....	Designing	1949	.....	Fluor	Fluor
Shell Oil Co.	Wilmington, Cal.	Add. Crk. Comp.	.....	.....	Under Constr.	1949	.....	Fluor	Fluor
Standard Oil Co. of Calif.	Bakersfield, Cal.	Ther. Crk. Gaso. Stabil., Treat.	9,000 bbls.	.....	Completed	.....	U.O.P.	U.O.P.	Braun
Union Oil Co. of Calif.	Brea Olinda, Cal.	Research Plant	.....	$5 million	Projected	Sept., 1950	.....	.....	.....
Union Oil of Calif.	Oleum, Calif.	Revise Ref'g.	.....	$4 million	Under Constr.	Dec., 1949	.....	Parsons, E. & A. Mathews, Montgomery	Ref. Maint., Early, C. N. Peterson, Mathews
Union Oil of Calif.	Oleum, Calif.	Improve Handling Facilities	.....	$1.5 million	Under Constr.	Dec., 1949	.....		
Union Oil of Calif.	Oleum, Calif.	Tankage and Utilities	.....	$1.8 million	Engineering	1st Qtr., 1950	.....	Parsons	Eaton & Smith, C.B.&I., Utah
Union Oil of Calif.	Oleum, Calif.	Main Office Addition, Shops, Misel.	.....	$1 million	Under Constr.	Dec., 1949	.....	Austin, Field & Fry, D. R. Warren Co., Montgomery	E. S. McKittrick, Parker, Steffens & Pierce
Union Oil Co.	Oleum, Calif.	Add. Ref. Facilities	.....	.....	Under Constr.	Feb., 1950	.....	.....	.....
FOREIGN									
Canada									
British-American Oil Co.	Edmonton, Alberta	Refinery	2 mln. yr.	.....	.....	.....	.....	.....	.....
*British-American Oil	Clarkson, Ontario, Can.	Propane Deasphalt.	700 bbls.	$400,000	Contracted	Mid., 1950	Standard Oil Development, Union Oil Co. (Calif.), Standard Oil Co. (Ind.)	Canadian Kellogg	Canadian Kellogg
Excelsior Refs., Ltd.	Lloydminster, Alberta	Cap. Increase	3,000 bbls.	.....	Under Constr.	1950	U.O.P.	U.O.P.	.....
Excelsior Refs., Ltd.	Lloydminster, Alberta	Capacity Inc.	1,800 bbls.	.....	Design	1950	.....	.....	.....
Hi-Way Refineries, Ltd.	Saskatoon, Saskatchewan	Crude Topping Unit	2,000 bbls.	.....	Under Constr.	Jan., 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Hi-Way Refineries	Saskatoon	Thermal Crack.	500 bbls.	.....	Under Constr.	Jan., 1950	U.O.P.	Ref. Eng.	Ref. Eng.
Imperial Oil, Ltd.	Leduc Field	Gas Absorption	24,000 mcf	$6.5 million	Under Constr.	Mid. 1950	.....	Braun	Braun
Imperial Oil	Regina, Saskatchewan	Add Distil. Equip.	3,000 bbls.	$360,000	Under Constr.	Jan., 1950	.....	Staff	Staff
Imperial Oil	Winnipeg	New Refinery	.....	.....	Planning	.....	.....	.....	.....
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Grease and Compounding	.....	.....	Projected	.....	.....	.....	.....
Shell Oil Co. of Canada, Ltd.	Montreal East, Quebec	Fluid Cat. Crk., Vac. Flash Gas Recov., Poly, Treat	35,000 bbls.	.....	Under Constr.	Late 1950	.....	Staff	Fluor, Ltd., McKee
Latin America									
Administracion Nacional Combustible Alcohol y Portland	Montevideo, Uruguay	Lube, Asphalt Units	7,500 bbls.	.....	Under Constr.	1st Qtr., 1950	.....	Foster Wheeler	Foster Wheeler
Conselho National do Petroleo	Mataripe, Bahia, Brazil	Thermal Cracking Refinery	5,000 bbls.	$2.5 million	Under Constr.	Jan., 1950	.....	Kellogg	Kellogg, Staff
Conselho Nacional do Petroleo	Santos Sao Paulo	Refinery	45,000 bbls.	.....	.....	.....	.....	.....	.....
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Refinery	.....	$3.6 million	Planning	Dec., 1950	.....	.....	.....
Creole Pet. Corp.	Amuay Bay, Venezuela	Crude Stills	60,000 bbls.	$175 million	Under Constr.	1950	.....	S.O.D.	Foster Wheeler, J. G. White
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring	.....	.....	Planning	.....	.....	.....	.....
Ipiranga S.A. e/a Brasilera de Petroleos	Rio Grande, Brazil	Topping, Thermal Cracking	3,000 bbls.	.....	Authorized	1952	Foster Wheeler	.....	.....
Mene Grande Oil Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.	.....	.....	.....	.....	.....	.....
Petroleos Mexicanos	Poza Rica, Mex.	Gas Purification Pressure Maint.	.....	$13 million	Contracted	Early 1950	.....	McKee	McKee
Petroleos Mexicanos	Salamanca, Mex.	Crd., Gasol, Crk.	25,000 bbls.	$12 million	Under Constr.	Early 1950	U.O.P.	McKee	McKee
Refinaria de Petroleo do Distrito Federal S.A.	Rio de Janeiro, Brazil	Complete Refinery	45,000 bbls.	.....	Authorized	.....	.....	.....	Fives, Lille, Schneider, Staff
Refinaria e Exploracao de Petroleo Uniao S.A.	Capuava, Sao Paulo, Brazil	Thermal Cracking Refinery	20,000 bbls.	.....	Authorized	.....	.....	Pan American Hydrocarbon Res., Inc.	Cook, Fast, Metal Work Mech. Constr.
Richmond Exploration Co.	Bajo Grande, Venezuela	New Refinery	35,000 bbls.	.....	Engineering	June, 1950	.....	.....	.....
Shell Caribbean Pet. Co.	La Paz, Venezuela	Gas Plant	90 tons	.....	Under Constr.	Early 1950	.....	.....	.....
Shell Caribbean Pet. Co.	Mara, Venezuela	Gas Plant	90 tons	.....	Projected	Early 1951	.....	.....	.....

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Shell Oil of Venezuela	Punta Cardon, Venezuela	Comprehensive Refining	30,000 bbls.	$32 million	Under Constr.	Mid 1951			
Venezuela Gulf Refining Co.	Puerto la Cruz, Venezuela	Refinery	30,000 bbls.	$5 million	Under Constr.	July, 1950		Lummus	Lummus
Venezuelan Pet. Co.	Puerto la Cruz, Venezuela	Refinery	35,000 bbls.		Under Constr.			Stone	Stone
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.	$54 million	Engineering	Late 1950		Kellogg	Kellogg
YPF	La Plata, Argentina	Crude Topping, Cano Treating	50,000 bbls.	$2.8 million	Under Constr.	1949		Houdry Process	Cat. Constr.
YPF Bolivianos	Corbalamba, Bolivia	Topping & Reforming Units	5,000 bbls.			3rd Qtr., 1950		Cat. Constr. Foster Wheeler	Foster Wheeler
Europe and Africa									
Anglo-American Oil Co.	Fawley, Eng.	Refinery Expansion	110,000 bbls.	$150 million	Under Constr.	Late 1952		Foster Wheeler	Foster Wheeler
Anglo-American	Fawley, Eng.	O_2 Extraction	13,000 bbls.		Design			Badger	Badger
Anglo-Iranian Oil	Isle of Grain, Eng.	Cent. Refg. Unit	80,000 bbls.	$120 million	Planning	1952			
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plant		$50-60 million	Contracted			Hydrocarbon Research	
Aquila, S.A.	Trieste, Italy	Lube Oil Refinery	100 tons		Design	Mar., 1951	Juik, Texaco	Badger	Badger
Azienda Generale Italiana Petroli	Rome, Italy	Add to Plant	24,000 bbls.		Projected	Late 1951			
Azienda Generale Italiana Petroli	Palermo, Italy	Marine Fuel Plant	7,500 bbls.						
Bataafsche Petroleum Mij.	Pernis, Holland	P.U.C. Plant	2,000 tons, yr.			Jan., 1950			
My. Bataafsche Pet.	Pernis, Holland	Expansion	50,000 bbls.		Under Constr.	Mid 1952			
British Petroleum Chem.	Grangemouth, Scotland	Petrochem			Under Constr.	Dec., 1950		Badger	Badger
Cabot Carbon, Ltd. (Godfrey L. Cabot, Inc.)	Ellesmere Port, Eng.	Carbon Black Plant	50,000 lbs., yr.		Under Constr.	1950		Simon-Carves, Ltd.	Simon-Carves, Ltd.
Caltex Pet. Maatschappij, N.V.	Rotterdam, Holland	Complete Refinery	20,000 bbls.	$18 million	Under Constr.	Feb., 1950		McKee, Badger, U.O.P.	McKee
Cie. de Raffinage Shell-Berre	Berre, France	Expansion	40,000 bbls.		Under Constr.	Mid 1951			
Shell	Petit-Couronne	Teepol Plant	25,000 tons, yr.			Mid 1950			
Cie. de Raffinage Shell-Berre	Petit Couronne, France	Lube Unit			Planned				
Cie. de Raffinage Shell-Berre	Petit-Couronne (Rouen), France	Expansion	10,000 bbls.		Under Constr.	Early 1950			
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.		Projected	1951	Texas	Kellogg-Lummus	
Cie. Francaise de Raffinage	Gonfreville, France	Distillation Unit	20,000 bbls.		Under Constr.	1950		Foster Wheeler	Foster Wheeler
Cie. Francaise de Raffinage	Provence, France	Topping Unit	20,000 bbls.	$11 million	Under Constr.	1950		Foster Wheeler	Foster Wheeler
Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife (Canary Islands)	Propane-Butane Fractionating, Propane-Deasphalting	304 bbls.	$100,000	Contracted	June-July, 1950		U.O.P.	U.O.P.
Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife (Canary Islands)	Propane-Butane Fractionating, Propane-Deasphalting	700 bbls	$300,000	Contracted	June-July, 1950	Standard Oil	Foster Wheeler	Foster Wheeler
Cia. Espanola de Petroleos, S.A. (C.E.P. S.A.)	Canary Islands, Spain	Furl. Ref. Sol. Dewax., Wax Fractnts.	5,000 bbls.	$4.5 million	Under Constr.	Early 1950	Texaco, Standard, N.J.	Foster Wheeler	Foster Wheeler
Condor, S.P.A. Per l Industriale Pet. Chemica	Rho, Italy	New Refinery	1 mln tons/yr.						
Danish Government	Denmark	Refinery	21,000 bbls.		Planned				
Egyptian Government	Cairo, Egypt	Crude Plant						Lummus	Lummus
Industria Chimoiko Italiane Petroli	Mantua, Italy	Crude	4,880 bbls						
Industria Nazionae Petroli e Trasformazione	Massa Carrara, Italy	Refinery	40,000 bbls.			Late 1951			
Industria Petrolifera e Chimica	Milan, Italy	Gasoline Fuel Oil Plant	20,000 bbls.					Dr. Calogero Togliero	
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit			Under Constr.	1950		Kellogg	Kellogg
Stand.-Azienda Gen. Indro. Comb. (Stanic)	Leghorn, Italy	Add Capacity	28,700 bbls.						
Ditto (Stanic)	Bari, Italy	Add Capacity	38,300 bbls.						
L'Alliance Petrolina	Antwerp, Belg.	Refinery	21,000 bbls.		Planned				
Manchester Oil Refinery, Ltd.	Partington, England	Cat. Crk., Lube Reforming	20,000 bbls.		Projected				
Monsanto Chemical Co.	Britain	Add Polystyrene			Design	Early 1950		Staff	Staff
National Oil Refineries, Ltd.	Llandarcy, Wales	Crude and Reform	40,000 bbls.		Completed			Badger	Badger
National Oil Refineries	Llandarcy, Wales	Lube Oil Ref. Refinery			Under Constr.		Juik, Texaco	Badger	Badger
National Oil Refineries	Llandarcy, Wales	Furf. Ref. Sol. Dewax., Wax Fractn.	1,200 bbls.	$36 million	Designing		Texaco	Badger	Badger
National Oil Refineries	Llandarcy, Wales	SO_2 Solvent Extraction	3,000 bbls.		Contracted			H.W.P.	
Petrofrance, S. A. E. M.	Merlwiller, France	Capacity Increase	1,550 bbls.		Authorized	1950			
Petro Carbon, Ltd.	Partington, England	Cat. Cracker, Lube & Reform	20,000 bbls.						
Petro Chem., Ltd.	Partington, England	Petro Chemicals	2,000 bbls.	$16 million	Under Constr.	1949	Petro-Carbon	Petro-Carbon	Petro-Carbon
Philblack, Ltd.	Avonmouth, England	Carbon Blk. Pl.	137,000 bbls.	$5 million	Contracted	1950	Phillips	H.W.P.	H.W.P.
Raf. de Pet. de Escom, S.A.	Cartagena, Spain	Refinery	20,000 bbls.		Under Constr.	July, 1951			
Raffinerie Belge de Petroles S.A.	Antwerp, Belgium	Therm. Crk., Reform., Gas Plant		$2 million	Under Constr.	1950		Barnes	Barnes
Raffineries de Petrole de la Gironde	Bec Ambes, France	Refinery	13,000 bbls.	$7.8 million	Reconstr.	Early 1950		U.O.P., McKee	McKee
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million					

■ CONTINUED ON PAGE 87

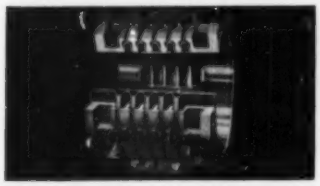
Zallea Expansion Joint News

Expansion Joint of the Month

PROTECTING $100,000 A DAY

DUO EQUALIZING TYPE

The ideal corrugated expansion joint is one in which all corrugations move simultaneously during expansion or contraction of the piping, and no corrugation can be compressed or extended more than the proportionate amount for which it is designed. This briefly describes the Zallea Duo Equalizing Expansion Joint, so called because it functions in two ways: equalizing the compression among the corrugations simultaneously when the pipe line is expanding and likewise distributing the elongation simultaneously and proportionately among all the corrugations when the line is contracting.



This is accomplished by the simple expedient of a pantograph. Two or more pantographic chains are superimposed on the equalizing rings of the expansion joint, the neutral points being anchored in the end fittings and intermediate equalizing rings. Any movement of the end fitting is immediately and simultaneously transmitted to all equalizing rings. In this manner all the equalizing rings move the same relative distance at the same time. This Zallea Joint is recommended for all intermittent steam services in long lines, institutions, and industrial plants.

. . . a complete, practical catalog on all Zallea Expansion Joints. A text book and a valuable reference source. Send for your *free* copy *today!*

ZALLEA BROTHERS, 890 Locust Street
Wilmington 99, Delaware.

Control in Manufacture

COPPER VS. STAINLESS STEEL

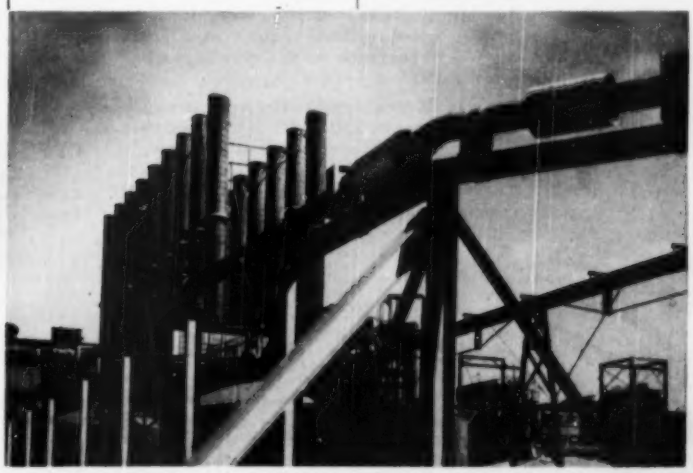
For many years, copper has been the accepted material for the corrugated elements of packless expansion joints for use on heating lines, pumps, turbines and condensers. However, with new expansion problems demanding higher strength and greater corrosion or temperature resistance, stainless steel has replaced copper in approximately 95% of the applications. Although slightly higher in initial cost, the use of stainless steel results in much lower final costs because of increased service life. Stainless steel corrugated elements can be made with a wall thickness approximately one-third of that required for copper to withstand the same working pressure. Since the life expectancy of a corrugated element varies inversely with the thickness of the metal, a stainless steel expansion joint will last many times longer than a copper expansion joint designed for the same operating pressure. The stainless steel used in the Zallea Expansion Joint may be of several alloys, depending upon temperature, corrosion and other service requirements.

ZALLEA EXPANSION JOINTS GUARD PLANT CAPACITY

At a large eastern industrial plant which has a production capacity of over $100,000 per day, Zallea Stainless Steel Expansion Joints serve as insurance against shutdown and costly delay. Failure of any one of the many expansion joints that are installed in the outdoor steam distribution line would result in major production loss. But the Zallea Joints installed here in 1933 still function safely and dependably. It's the *quality* built into every Zallea Expansion Joint that makes them last!

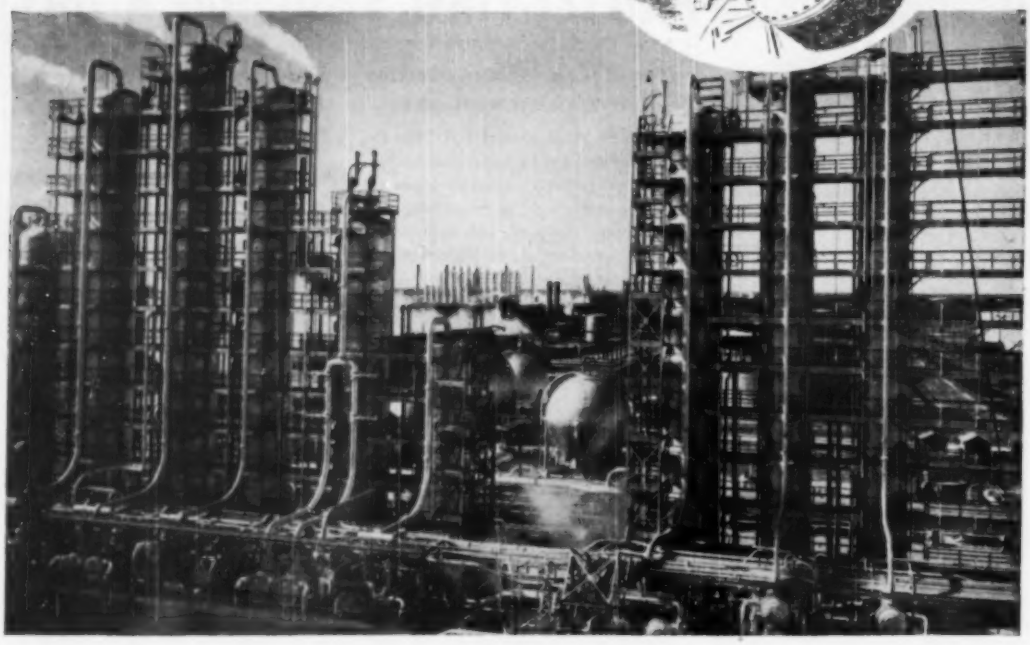
No Maintenance Required

Built expressly to absorb expansion and contraction of pipe lines due to thermal changes, Zallea Stainless Steel Expansion Joints will serve dependably and economically under the severest of installation operating conditions. There's no packing to deteriorate—no maintenance is required. For normal steam line operation, Zallea Stainless Steel Expansion Joints will outlast the line itself!



STAINLESS STEEL TOWER INTERNALS SAVE WEIGHT AND GAIN SPACE. Thinner, lighter-weight stainless steel sections simplify fractionating tower structural problems . . . allow space for more efficient manways . . . increase the efficiency of bubble caps and trays. And, smooth, pore-free stainless steel surfaces discourage coking and fouling. ENDURO Stainless and Heat-Resisting Steels currently are helping refiners maintain profitable throughput in cracking stills and tubes, condensers and heat exchangers, still linings, hot oil lines, sludge tanks, swing lines, valves and many more items of equipment.

Enduro-THRIFTY METAL OF 10,000 USES



. . . STRENGTH? YES, AND LIGHT WEIGHT, TOO

High strength—at both frigid and torrid temperatures—traditionally is identified with Republic ENDURO Stainless Steel. It is this property which results in another characteristic of vital importance to the ever-expanding petroleum industry—*light weight.*

Because of its exceptionally high strength-to-weight ratio, ENDURO is used in thin, light-weight sections without loss of strength or durability, and without sacrifice of safety. Today, with refinery operations calling for increasingly enlarged and complex construction, the high strength and fatigue-resistance of stainless steel open vast new design opportunities—unhampered by material limitations.

There are many analyses of ENDURO Stainless and Heat-Resisting Steels, each developed to meet specific requirements of various refinery applications. For further information and factual data, write us:

REPUBLIC STEEL CORPORATION

Alloy Steel Division • Massillon, Ohio

GENERAL OFFICES • CLEVELAND 1, OHIO

Export Department: Chrysler Building, New York 17, N. Y.

Enduro **STAINLESS STEEL**

REG. U. S. PAT. OFF.

REPUBLIC STEEL

✓ **Check ALL 10 Advantages!** • RUST AND CORROSION-RESISTANCE • HEAT-RESISTANCE • HIGH STRENGTH • NO METALLIC CONTAMINATION • SANITARY SURFACES • EASY TO CLEAN • EYE APPEAL • EASY TO FABRICATE • LONG LIFE • LOW END COST.

REFINERY AND OTHER PLANT CONSTRUCTION (Continued)

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Visbreaker	.....	.....	.....	Early 1950	.....	Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Topping Unit	15,000 bbls.	.....	Under Constr.	Late 1949	.....	Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Solvent Treating	1,000 bbls.	.....	Under Constr.	Early 1950	Texaco	Staff	Staff
Socony-Vacuum Italiana, S.p.A.	Naples, Italy	Reformer	5,000 bbls.	.....	Under Constr.	Early 1950	.....	Staff	Staff
Raffinerie Siciliane Oli Minerali, S.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.	.....	Designing	Early 1950	U.O.P.	U.O.P., Delta	S. T. I. I.
Scottish Oils, Ltd.	Grangemouth, Scotland	Crude	38,000 bbls.	$28 million	Designing	.....	.....	Kellogg	Kellogg
Scottish Oils, Ltd.	Grangemouth	Cat. Crk.	5,000 bbls.		Planned	.....	.....	.....	.....
Shell Chemical Mfg. Co., Ltd.	Thornton, Eng.	Teepol Plant Extension	75,000 tons per Year	.....	Under Constr.	Jan., 1950	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Stanlow, Eng.	Comprehensive Refining	60,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Comprehensive Refining	40,000 bbls.	.....	Under Constr.	Mid 1953	.....	.....	.....
Societe Generale des Huiles de Petrole	L'Avera, France	LPG Units	25,000 bbls.	.....	Under Constr.	Mid 1950	Kellogg	Kellogg	Staff
Societe Generale	Dunkirk, France	Crude Reform.	33,000 bbls.	.....	Under Constr.	Mid 1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg
Societe Generale	Dunkirk, France	Furf. Ref. Sol. Dewax., Wax Fractn.	2,600 bbls.	.....	Designing	Mid 1951	Texaco	Lummus	Lummus
Societe Industrial Belgique de Petrole	Antwerp, Belgium	Crude, Cracking Reforming	30,000 bbls.	.....	Designing	Mid 1951	.....	.....	.....
Societe Raffinazione Oli Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Asid Treat., Contract Filtration for Lube Oils, Electric Gen. Unit, Lond. Facilities	1 mln. tons year	$6.4 million	Contracted	.....	.....	H.W.P.	H.W.P.
Societe per Azioni Raffinerie Padane Oli Minerali	San Martino di Trevale, Italy	Refinery	13,000 bbls.	.....	Proposed	.....	.....	.....	.....
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.	.....	Design	Mid 1950	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Propane Deasphalting	1,100 bbls.	.....	Design	Mid 1950	Juik	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding	.....	.....	Under Constr.	Mid 1950	.....	Staff	Staff
Standard Francaise des Petroles	Port Jerome, France	Dewaxing Plant	1,000 bbls.	.....	Planned	.....	.....	.....	.....
Standard Francaise des Petroles	Port Jerome, France	Deasphalting Plant	2,000 bbls.	.....	Planned	.....	.....	.....	.....
Standard Oil Co., (N.J.)	Belgium	Dist. Crack.	33,000 bbls.	.....	Planned	Early 1952	.....	.....	.....
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved	.....	.....	.....	.....
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Africa	New Refinery	.....	$20 million	Projected	.....	.....	.....	.....
Near East									
Anglo-Iranian Oil	Abadan, Iran	Gas Plant	25,000 mcf	$2 million	Under Constr.	1950		Badger	Badger
Anglo-Iranian	Abadan, Iran	Cat. Cracker	30,000 bbls.		Under Constr.	1951		Foster Wheeler	Foster Wheeler
Anglo-Iranian	Abadan, Iran	Solvent Dewax.	400 bbls.		Under Constr.		Texaco	Badger	Badger
Anglo-Iranian	Abadan, Iran	Gas Recov., Stab.	22,000 mcf		Under Constr.	Mar., 1951		Badger	Badger
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabilizer	300,000 bbls.	$4.8 million	Under Constr.	Summer 1950		Staff and Fluor	Staff and Fluor
Arabian American	Ras Tanura, S.A.	Ref. Adds.	.....	.....	Under Constr.	1950		Bechtel	Int. Bechtel, Inc.
Arabian American	Ras Tanura, Saudi Arabia	Asphalt Plant	500 bbls.	$1,250	Plans Approved	1950		Staff, Bechtel	Staff
Bahrein Pet. Co., Ltd.	Bahrein Island	Expansion	.....	$8.3 million	Under Constr.	4th Qtr., 1949		U.O.P., Bechtel	Int. Bechtel, Inc.
Bahrein Pet. Co., Ltd.	Bahrein Island	Crd. Still Util.	55,000 bbls.	$9.1 million	Under Constr.	Aug., 1950		Lummus, Bechtel	Int. Bechtel, Inc.
Consolidated Ref., Ltd.	Haifa, Palestine	Crude Plant	80,000 bbls.		Planned	Late, 1951		Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	Cen. Facilities	.....		Under Design	.....		Badger	Badger
Consolidated Ref., Ltd.	Haifa, Palestine	Lube Plant	2,500 bbls.		Designing	.....	Texaco, Juik	Lummus, Kellogg	Lummus, Kellogg
Far East									
Batoafsche Pet. Mij. (Shell)	Balikpapan, Borneo, East Indies	Expansion	42,000 bbls.		Under Constr.	Mid 1952			
Batoafsche Pet. Mij.	Pladjoe, Sumatra	Rehab. to Comprehensive Refg.	70,000 bbls.		Under Constr.	Mid 1951			
Burmah Oil Co., Ltd.	Syriam, Burma	Furf., Sol. Dewax., Wax Mfg.	1,000 bbls.	$600,000	Designing	.....	Texaco	Badger	.....
Burmah Oil Co.	Syriam, Burma	Thermafor Clay Revivification	66 tons	$150,000	Design	1950	Max Miller, Socony-Vacuum	Max Miller	
Oceania									
Australian Shell Oil Co.	Clyde, New S. W., Australia	Luboil Refining	280 bbls.	.....	Under Constr.	Late 1950	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery	.....	$4.8 million	Under Constr.	Late 1951			
Australian Shell Oil Co.	Geelong, Victoria, Australia	Bitumen and Luboil Plant	.....	.....	Projected	.....	.....	.....	.....
Australian Shell Oil Co.	Geelong, Victoria, Australia	Asphalt, Lube Solvent Extraction Plants	.....	.....	.....	.....	.....	.....	.....

* First appearance in tabulation. † Added capacity.

NOTE: Badger—E. B. Badger & Sons. Barnes—W. M. Barnes & Co. Bechtel—Bechtel Corp. Bellows—W. S. Bellows Co. Blaw-Knox—Blaw-Knox Construction Co. Bowden—W. H. Bowden. Braun—C. F. Braun Co. Brown Eng.—Brown Engineering Co. Brown & Root—Brown & Root Construction Co. Canadian Kellogg—Canadian Kellogg Co. Cat. Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C.B.&I.—Chicago Bridge & Iron Works Co. Clarke—Clarke Construction Co. Constr. Service—Construction Service Co. Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. E.&A.—Ehrhart & Arthur, Inc. Ferguson—H. K. Ferguson. Fish Eng.—Fish Engineering Corp. Fluor—Fluor Corp. Foster Wheeler—Foster Wheeler Corp. Gaso. Plant—Gasoline Plant Construction Co. General American—General American Transportation Co. Girdler—The Girdler Corp. Graff—Graff Engineering Co. Grebe & Dore-mus—Grebe & Doremus Process Co. Hammond—Hammond Iron Works Co. Houdry—Houdry Corp. Hudson—Hudson Engineering Corp. H.W.P.—Head Wrightson Processes, Ltd. Hydro Res.—Hydrocarbon Research, Inc. Ind. Eng.—Industrial Engineers, Inc. J.&L. Constr.—Construction Division, Jones & Laughlin Supply Co. Kellogg—M. W. Kellogg Co. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Knowles—Morris Knowles & Co. Knuteon—Knuteon Construction Co. Leonard—Leonard Construction Co. Lummus—The Lummus Co. Mahoney—Mahoney Contracting Co. Mason—Mason Brothers Construction Co. Mathews—Mathews Conveyor Co. McKee—Arthur G. McKee Co. Max Miller—Max B. Miller & Co. Michael Poling—Michael-Poling Construction Co., Inc. Montgomery—J. M. Montgomery & Co. Parsons—The Ralph M. Parsons Co. Perco—(Division) Phillips Petroleum Co. Pet. Eng.—Petroleum Engineering Inc. Petreco—Petroleum Rectifying Co. Pritchard—J. F. Pritchard Co. Process Eng.—Process Engineers, Inc. Process Constr.—Process Construction Co. Ref. Eng.—Refinery Engineering Co. Ref. Maint.—Refinery Maintenance Co., Inc. Rust. Eng.—Rust Engineering Co. Rust Pro.—Rust Process Design Co. Schenider—Schneider & Cie. Snare—Frederick Snare Corp. Sollitt—Summer S. Sollitt Co. S.O.D.—Standard Oil Development Co. State Eng.—State Engineering Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Tellepsen—Tellepsen Construction Co. Texaco—Texaco Development Co. U.O.P.—Universal Oil Products Co. Utah—Utah Construction Co. Voorhees, Walker, Foley & Smith. Walsh—Walsh Engineering. West—F. S. West Construction Co. Wohfeld—Wohfeld Construction Co. Equally owned California Texas Corp. and Socony-Vacuum Oil Co., Inc.

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PETROLEUM
REFINER
JANUARY, 1950

Furfural Unit Showing Extract Tower, a Fractionator, Industrial and Motor Oil Treating Towers. Steam stripping towers are in background.

SOLVENT REFINING processes have in recent years assumed high importance in the manufacture of lubricating oils and several other refinery products. Because the processes have been in general use for comparatively less time than have the distillation processes their optimum operating conditions are much less clearly established. Investigation and improvement in the techniques of solvent refining is proceeding, however, at a rapid pace and much progress has been made. This present article contributes another item to our store of knowledge of such processes. In the not-too-distant future perhaps we will reach a level of understanding where we can design extraction columns as precisely as we now select fractionators.

Temperature Gradient In Solvent Extraction Of Lubricating Oils

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THE use of a temperature gradient, i.e., maintenance of a higher temperature at the raffinate than the extract outlet, is often considered essential to insure the maximum yield of a fixed quality raffinate. This is believed to induce an internal reflux resulting in a favorable change of equilibrium between the raffinate and extract phases. Several patents have been issued concerning the use of a temperature gradient in commercial practice.[1,2,6] Kalichevsky[3] states, however, that temperature gradient becomes significant when the number of extraction stages is small and that maximum benefit is realized

TABLE 1

Properties of Lubricating Oil Distillate Stocks A, B, C and D

	MID-CONTINENT			COASTAL
	Stock A	Stock B	Stock C	Stock D
Gravity, °API	28.7	27.3	27.4	22.4
Flash, °F.	410	410	410	380
Color, ASTM	T.R	4½	T.R.	D 3.
SUV @ 130° F.	80"	89"	104"	107"
Viscosity-Gravity Constant	0.834	0.841	0.836	0.872

only when the extraction system has a low efficiency, Reeves[4] derived a theoretical relationship showing that the temperature gradient has an optimum depending on the number of extraction stages but that the importance of maintaining a gradient disappears rapidly as the number of extraction stages is raised.

The amount of experimental work on temperature gradient published in the literature is very meager and the available information is usually difficult to analyze. Likewise, the reported data often include a large experimental error which complicates the problem still further. The qualitative rather than the quantitative nature of such accounts made it desirable to conduct experiments with the purpose of determining whether maintenance of a temperature gradient in commercial operations is of real importance for insuring maximum recovery of a fixed quality product. In the present work furfural was used as solvent and the number of extraction stages was reduced to three, the approximate equivalent efficiency of commercial furfural extraction towers. Although most of the work was done in a continuous laboratory furfural treater, the results thus obtained were verified in commercial equipment.

Properties of the Mid-Continent and Coastal stocks studied are shown in Table 1. These oils were extracted with and without the use of a 30-40° F. temperature differential. Laboratory yields were calculated by two different methods: material balances and gravity differential which agreed within 1 percent of the average.

Raffinate samples produced from the laboratory three stage extractions were compared with respect to both yield and quality. These data are shown in Table 2. Examination of the data reveals that the raffinate yield is slightly higher but the viscosity index is somewhat lower than in extractions employing a temperature gradient. For example, in extracting distillate Stock C using a temperature differential of 40° F. the raffinate yield was 78 percent volume and viscosity index 92.8. Without a temperature differential the raffinate yield was 80 percent volume and viscosity index 88.5. A slight increase in temperature for constant temperature extractions will thus produce a raffinate of the same yield and quality as that obtained by employing a temperature differential.

On the basis of laboratory results a series of test runs were made on the commercial furfural unit, using a constant solvent to oil ratio but varying the extraction temperature differential within the limits employed in the laboratory runs. Plant tests were conducted on Stocks A and B. Results of these runs appear in Table 3.

Constant temperature extraction tests were conducted using the same temperatures as those maintained at the extract outlet when the temperature gradient was employed. As indicated by the laboratory data, a slightly higher raffinate yield but a lower viscosity index product was secured during the constant temperature extraction as compared with the extractions using a differential. By raising the extraction temperature to a level about 5-10° F. higher than the extract outlet temperature in the corresponding temperature gradient tests, a raffinate of the same yield and the same quality was secured.

Conclusion

The above data show that the effect of a temperature gradient in commercial operations at three extraction stages is very small and for all practical purposes may be considered negligible.

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ACKNOWLEDGMENT

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TABLE 2

Laboratory Furfural Extractions of Various Lubricating Oil Distillates (3 Stage Extractions)

Distillate Stock	Extraction Temp. °F. Raffinate Phase	Extract Phase	Temp. Gradient °F.	Solvent Treat Percent Vol.	RAFFINATE Yield Percent Vol. Gravity	Material Balance	Average	Viscosity Gravity Constant	DEWAXED RAFFINATE 20° F. POUR POINT Viscosity Index
A	230	200	30	150	77	77	77	0.810	.....
	200	200	0	150	80	80	80	0.811	.....
C	220	180	40	150	79	77	78	0.814	92.8
	180	180	0	150	81	79	80	0.816	88.5
D	200	170	30	200	60	61	61	0.827	68.5
	170	170	0	200	63	64	64	0.838	62.0

TABLE 3

Plant Furfural Unit Extractions of Various Lubricating Oil Stocks

Distillate Stock	EXTRACTION TEMP. °F. Raffinate Phase	Extract Phase	Temp. Grad. °F.	Solvent Treat Percent Vol.	Raffinate Yield, Percent Vol.	Dewaxed Raffinate 20° F. Pour Point Viscosity Index
A	230	200	30	150	75.0	116.6
	200	200	0	150	77.0	113.2
B	260	225	35	215	55.0	103.6
	225	225	0	215	58.0	102.5
	230	220	0	215	57.0	103.4

* * *

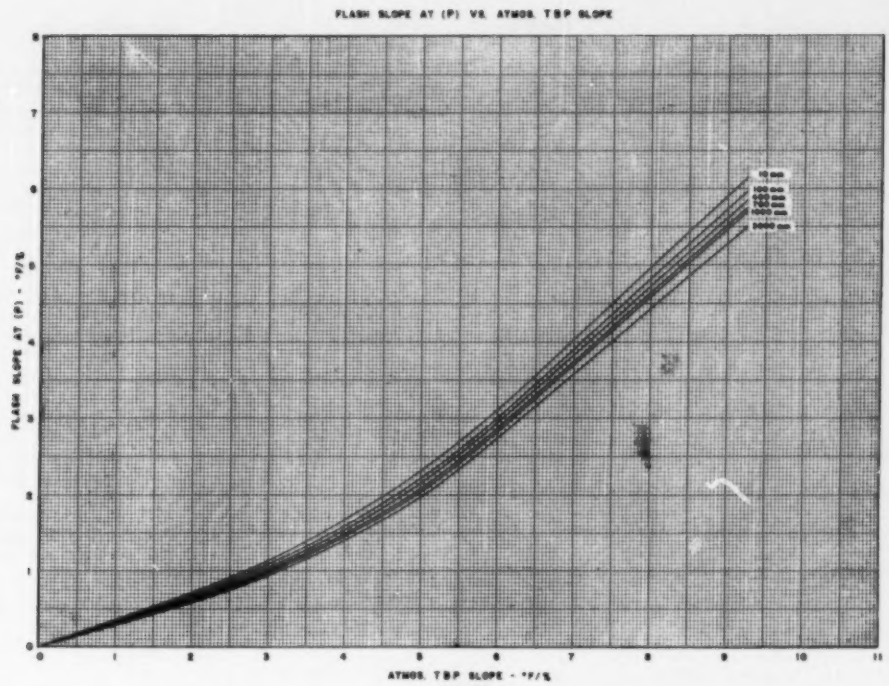

FIGURE 1

Evaluation of Vacuum Flash Vaporization Curves from Atmospheric True Boiling Point Distillation

K. KEITH OKAMOTO AND M. VAN WINKLE
University of Texas, Austin

***THE AUTHORS** present here a new and simplified correlation of true boiling point and flash vaporization curves which requires for use only a knowledge of the atmospheric true boiling point data. From such data the vacuum equilibrium flash curves at any sub-atmospheric pressure may be constructed. These correlations are based on previous work reported by the authors but include compressibility and volumetric basis corrections. Comparison of results with those from other methods of obtaining equilibrium flash curves from analytical data are included.*

***Okamoto** is a graduate student at the University of Texas, Austin while Van Winkle is associate professor of chemical engineering at the same school.*

THE design of petroleum vacuum columns requires among other things a knowledge of the vapor-liquid equilibrium properties of the stocks to be fractionated and the products resulting from the fractionation. At atmospheric pressure and to a lesser extent at pressures above atmospheric, sufficient experimental data have been developed to enable the evaluation of empirical correlations relating vaporization characteristics of petroleum oils on the basis of analytical and equilibrium distillation curves. At subatmospheric pressures little or no data have been published. Therefore, the evaluation of empirical correlations relating flash and analytical curve data cannot be accomplished in the same manner as was done in the case of higher pressure distillations.

In the absence of experimental data the problem of developing suitable correlations may be approached either from the standpoint of extrapolation of existing correlations into the subatmospheric range or by application of basic vapor-liquid equilibrium theory to mathematical analysis of hydrocarbon mixtures whose composition and volatility characteristics are known, and the inclusion of factors correcting for the deviation of the mixtures from ideal behavior.

In a recent paper[1] a correlation was presented relating the 50 percent temperature of the true boiling point distillation curve with the equilibrium flash curve 50 percent temperature at pressures ranging from 10 mm. of mercury to 3000 mm. of mercury. In addition, true boiling point distillation curve 10 percent-70 percent slopes were correlated with equilibrium flash vaporization curve 10 percent-70 percent slopes over the same pressure

TABLE 1
Comparison of Temperatures on Molal and Volumetric Basis

	FLASH CURVE TEMPERATURE—°F.					
	10 Percent		50 Percent		70 Percent	
	Molal	Vol.	Molal	Vol.	Molal	Vol.
P = 10 mm	12.0	27.5	138.6	193.8	203.2	230.2
	10.3	18.0	84.2	97.2	115.3	122.2
	128.8	134.0	197.0	208.3	225.7	232.0
P = 100 mm	103.0	118.2	229.7	270.0	293.0	314.6
	97.6	105.0	169.2	180.0	198.5	204.0
	251.8	255.5	298.2	302.0	330.7	336.0
P = 400 mm	224.2	241.0	349.0	386.6	407.3	429.0
	211.7	218.3	277.8	287.5	305.8	311.8
	363.0	367.0	430.0	436.3	444.0	447.2
P = 760 mm	179.5	194.3	308.0	345.7	366.3	387.0
	170.0	177.0	238.0	248.0	266.8	272.0
	315.6	319.3	373.5	380.7	389.0	403.8
	TBP CURVE TEMPERATURE—°F.					
	10 Percent		50 Percent		70 Percent	
	Molal	Vol.	Molal	Vol.	Molal	Vol.
P = 10 mm	−50.0	−25.0	4.5	207.0	227.0	273.0
	−58.0	−28.0	−4.3	109.0	135.0	155.0
	66.5	76.0	197.0	221.0	252.0	269.0
P = 100 mm	0.0	45.0	226.5	305.0	326.5	377.0
	0.0	42.5	170.0	197.0	226.5	249.0
	150.0	161.0	295.0	320.0	358.0	372.0
P = 400 mm	97.0	138.0	343.5	434.0	457.5	517.0
	97.0	135.0	280.7	312.0	343.0	370.5
	258.0	270.0	421.3	446.0	490.0	508.0
P = 760 mm	65.0	104.0	299.5	386.0	409.0	464.0
	65.0	101.0	230.0	270.0	301.0	325.0
	218.0	229.0	375.0	404.0	440.0	460.0

range. These correlations were derived from flash curves computed from selected multicomponent hydrocarbon mixtures on the basis of mole percent vaporized and assumed ideal behavior of both the vapor and liquid phases. The correlations thus derived were considered to be less than satisfactory, first because of the necessity of conversion of the analytical TBP data determined in the laboratory on the volumetric basis to the mole basis, and second, because further mathematical investigation using the Watson and Smith[2] generalized compressibility chart indicated that an appreciable error, particularly in the 50 percent boiling point correlation, was introduced by the original assumption of ideal behavior of the vapors at sub-atmospheric pressures. The error was negligible at very low pressures, i.e. at 10 mm. of mercury, but increased as the pressure increased to atmospheric pressure and above.

Conversion from Mole to Volume Basis

The equilibrium flash curves for the nine hydrocarbon mixtures at the different pressures considered and at the different mole per cents vaporized were converted to the volumetric percent basis by means of the following equations:

$$V = \frac{y_1 m_1}{d_1} + \frac{y_2 m_2}{d_2} + \cdots + \frac{y_n m_n}{d_n} \quad (1)$$

where:

V = total volume of vapor per mole vaporized
y = mole fraction of component in the vapor
m = molecular weight of component
d = liquid density of pure component at 60° F.

The molal volume of the mixture was determined by equation (1). The molal volume of the fraction vaporized was then calculated by means of equation (2).

$$V_f = \frac{y_{f_1} m_1}{d_1} + \frac{y_{f_2} m_2}{d_2} + \cdots + \frac{y_{f_n} m_n}{d_n} \quad (2)$$

where:

V_f = volume of the fraction vaporized per mole of fraction
y_f = mole fraction of the component in the vapor

The volume percent vaporized was then determined by equation (3).

$$v = \frac{V_f}{V}(n)\ (100) \quad (3)$$

where:

v = volume percent vaporized
V_f = molal volume of fraction vaporized
V = molal volume of the original mixture (of the original composition)
n = mole fraction vaporized.

The volume percents thus computed for the equilibrium flash vaporization for all the mixtures at the sub-atmospheric pressures considered were plotted versus temperature. This gave the equilibrium flash curves on a volume percent vaporized-temperature basis.

The true boiling point curves were converted to this basis in the same manner.

Table 1 lists a comparison of several 10 percent, 50 percent and 70 percent distilled points with the corresponding temperatures for the mole percent and volume percent basis for both the TBP and the flash curves.

Correction of 10% - 70% Slopes to Volumetric Basis

The 10 percent-70 percent slopes for both the TBP and flash curves were recomputed on the volumetric basis. Table 2 shows a comparison of the slopes for the two types of curves on the molal and volumetric basis. The deviation in slope is shown to be proportionately much less than the deviation in temperature. The reason for this is that the relative volatility changes much less than the volatility (represented by one point on curve).

TABLE 2
Comparison of 10 percent-70 percent Slopes on Molal and Volumetric Basis

	Flash 10 Percent-70 Percent Slope	
	Molal	Volumetric
P = 10 mm.	3.270	3.380
	1.780	1.737
	1.612	1.633
P = 100 mm.	3.175	3.285
	1.697	1.650
	1.475	1.512
P = 400 mm.	3.052	3.196
	1.568	1.600
	1.347	1.338
P = 760 mm.	3.111	3.280
	1.607	1.606
	1.383	1.403
	TBP 10 Percent-70 Percent Slope	
	Molal	Volumetric
P = 10 mm.	4.737	4.967
	3.220	3.050
	3.092	3.218
P = 100 mm.	5.392	5.530
	3.625	3.445
	3.417	3.532
P = 400 mm.	6.010	6.315
	4.138	3.915
	3.867	3.965
P = 760 mm.	5.733	6.000
	3.937	3.731
	3.700	3.850

Effect of Compressibility on Distillation Curves

The basis for the correction of the distillation curves for the effect of non-ideal behavior of the vapor is shown in the following development. The ideal gas law equation for one mole incorporating compressibility is:

$$PV = ZRT \quad (4)$$

where

P = pressure (absolute)
V = volume
Z = compressibility factor
R = gas law proportionality factor
T = temperature (absolute)
(all in consistent units)

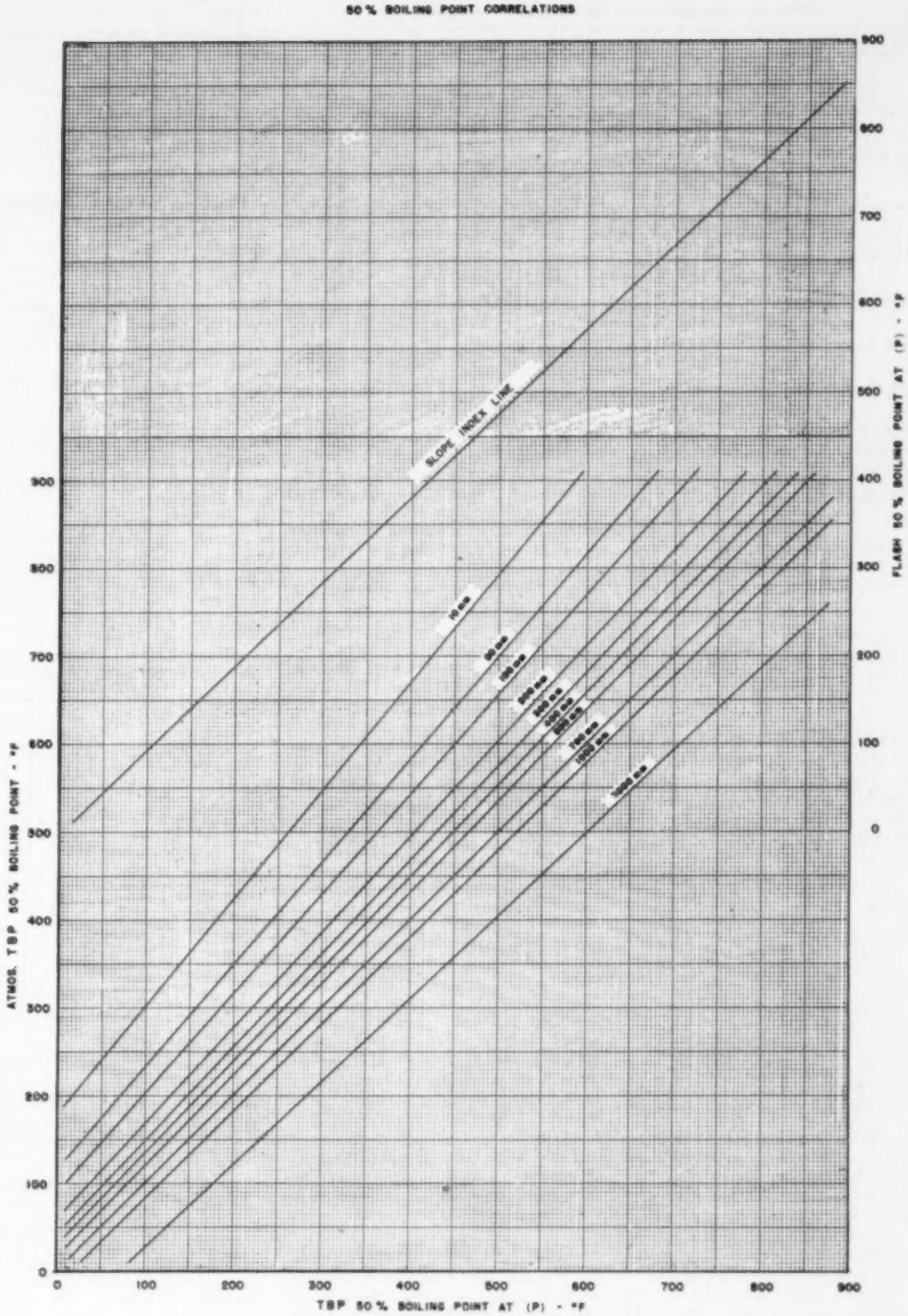
50 % BOILING POINT CORRELATIONS
SLOPE INDEX LINE
10 cc
20 cc
30 cc
40 cc
50 cc
60 cc
70 cc
80 cc
90 cc
100 cc
ATMOS. TBP 50 % BOILING POINT - °F
FLASH 50 % BOILING POINT AT (P) - °F
TBP 50 % BOILING POINT AT (P) - °F
0
100
200
300
400
500
600
700
800
900

FIGURE 2

TABLE 3

Effect of Compressibility on Flash Curve Temperatures

		FLASH CURVE TEMPERATURE—°F.					
	Compressibility Factor (Z)	10 Percent		50 Percent		70 Percent	
		Uncorrected	Corrected	Uncorrected	Corrected	Uncorrected	Corrected
P=10 mm	1.000	18.0	18.0	97.0	97.0	122.2	122.2
	1.000	9.4	9.4	36.0	36.0	51.2	51.2
	1.000	134.0	134.0	208.0	208.0	233.0	232.0
P=100 mm	0.995	108.0	108.0	180.0	183.0	204.0	207.0
	0.966	91.5	93.0	119.0	121.0	129.3	132.3
	0.994	238.3	240.0	302.0	307.0	326.0	331.0
P=400 mm	0.986	177.0	168.0	248.0	258.0	272.0	282.2
	0.986	160.0	168.0	185.0	194.0	195.6	205.0
	0.982	319.3	333.0	381.0	396.0	403.8	419.0
P=760 mm	0.975	218.3	236.0	288.0	307.0	311.8	331.5
	0.979	194.4	213.0	223.0	235.0	233.0	248.0
	0.971	367.0	391.5	420.0	453.0	447.2	474.5
P=1000 mm	0.972	238.5	258.5	306.0	330.0	324.7	351.5
	0.972	216.2	235.5	240.0	260.0	250.5	271.0
	0.965	389.5	430.0	447.0	480.0	469.0	502.5
P=3000 mm	0.940	326.0	376.2	392.0	446.0	415.0	470.5
	0.940	301.0	350.0	323.0	373.0	332.2	383.0
	0.938	491.0	567.0	547.0	628.0	564.0	650.0

For ideal behavior at very low pressures, $Z = 1.0$, thus:

$$P_1V_1 = RT_1 \quad \ldots\ldots(5)$$

For actual behavior:

$$P_aV_a = Z_aRT_a \quad \ldots\ldots(6)$$

Assuming that the entire deviation from ideal behavior can be shown in the temperature term, i.e. $P_aV_a = P_1V_1$, then:

$$\frac{P_aV_a}{P_1V_1} = \frac{Z_aRT_a}{RT_1} \quad \ldots\ldots(7)$$

and

$$T_a = \frac{T_1}{Z_a} \quad \ldots\ldots(8)$$

The temperatures for the volumetric flash slopes were corrected on this basis using the Watson and Smith[2] generalized compressibility chart which correlated compressibility with reduced pressure and reduced temperature.

$$P_r = \frac{P_a}{P_c} \quad \ldots\ldots(9)$$

$$T_r = \frac{T_a}{T_c} \quad \ldots\ldots(10)$$

where:

P_r = reduced pressure

P_a = actual pressure

P_c = critical pressure

and:

T_r = reduced temperature

T_a = actual temperature (absolute)

T_c = critical temperature (absolute)

The critical temperatures and pressures were derived from the Watson and Smith[2] correlation.

The computation of the true temperature was a trial and error calculation involving the estimation of the true temperature, calculation of the reduced temperature corresponding to the estimated value, obtaining the corresponding compressibility factor and calculating (T_a) from equation (8). This procedure was repeated until the estimated and calculated true temperatures agreed.

New flash curves were then drawn for all the mixtures at the various sub-atmospheric pressures on the volumetric basis incorporating compressibility. It was noted that for a given mixture at constant pressure the compressibility factor was substantially constant for the different per cents vaporized, having a maximum variation of 0.3 percent. Also the compressibility factor increased with decrease in pressure and was essentially unity at 10 mm. of mercury pressure. Table 3 gives a comparison of the equilibrium flash curve 10 percent, 50 percent and 70 percent temperatures on the volumetric basis both uncorrected and corrected for compressibility.

Correction of Flash Slope for Compressibility

The flash curve 10 percent-70 percent slopes were recomputed using the corrected temperatures from the volumetric flash curves. Again it was noted that the deviation of the corrected and uncorrected slopes was relatively small. The mean deviation was found to be less than 3 percent. The deviation in actual flash temperatures was much greater as seen in Table 3. The smaller slope deviation is the result of change in relative volatility rather than change of absolute volatility at any one point.

Table 4 includes a comparison of the corrected and uncorrected (for compressibility) equilibrium flash curve 10 percent-70 percent slopes.

Effect of Non-ideality of Liquid

Little data are available on activity coefficients for complex mixtures of hydrocarbons or for binary systems of the higher boiling hydrocarbons. Sage and Lacey[4] conclude that deviations of the activity coefficients from a value of 1.0 for hydrocarbon systems around atmospheric pressure are less than 1 percent. If this is true, at lower pressures the effect of activity coefficient on the flash curves should be negligible, and no serious error in the present calculations should result by assuming ideal solutions (activity coefficient = 1.0).

Flash and TBP Correlations

Use of the original correlations[1] presented by the authors involved the determination of the slope of the TBP at the pressure desired and then the determination of the flash slope from the TBP slope at the corresponding pressure. The 50 percent flash temperature at (P) pressure was determined from the 50 percent TBP temperature at (P) pressure.

The present correlations are decidedly advantageous over the former because the flash slope and 50 percent temperature at (P) pressure may be determined directly from the atmospheric TBP curve data.

Figure 1 presents the flash curve slope as a function of the atmospheric TBP slope with parameters of constant pressure. Thus the flash slope

TABLE 4

Comparison of Flash 10 Percent-70 Percent Slopes, Corrected and Uncorrected for Compressibility

	Flash 10 Percent-70 Percent Slope	
	Uncorrected	Corrected
P=10 mm.	1.737	1.737
	0.607	0.607
	1.633	1.633
P=100 mm.	1.640	1.650
	0.628	0.632
	1.512	1.517
P=400 mm.	1.582	1.606
	0.593	0.603
	1.408	1.433
P=760 mm.	1.561	1.600
	0.576	0.593
	1.338	1.400
P=1000 mm.	1.552	1.599
	0.572	0.587
	1.304	1.395
P=3000 mm.	1.482	1.578
	0.520	0.555
	1.262	1.387

TABLE 5

Comparison of Flash Slopes Obtained From Various Correlations at 760 mm. Mercury for the Nine Hypothetical Mixtures

Mixture	Atmospheric Flash 10 Percent—70 Percent Slope		
	Values From Figure 1	Nelson and Harvey	Edmester and Pollock
1	0.490	0.490	0.517
2	0.930	1.125	1.192
3	1.530	1.680	1.715
4	3.125	3.750	3.350
5	5.575	6.300	6.020
6	1.435	1.700	1.787
7	0.580	0.820	0.840
8	1.475	1.820	1.615
9	1.460	1.820	1.733

may be read directly from the plot at any subatmospheric pressure when the atmospheric pressure TBP slope is known. The flash slope values obtained from Figure 1 show a mean deviation from calculated values of 2.97 percent.

Figure 2 presents the 50 percent flash temperature as an indirect function of the atmospheric 50 percent TBP temperature with parameters of constant pressure. The correlation is used as follows:

The atmospheric pressure 50 percent TBP temperature is found on the ordinate at the left. Move horizontally to the right until intersection with the desired constant pressure line is reached. Move vertically until intersection with the Slope Index line is reached. Then move to the right horizontally and read the 50 percent flash temperature at (P) on the right hand ordinate scale.

Figure 3 shows the comparison of correlations relating the TBP and flash 50 percent temperatures. Included are the relationships on the mole basis with no compressibility correction, volume basis with no compressibility correction and volume basis with compressibility correction.

Edmister and Pollock's[5] method of evaluating the equilibrium flash vaporization curves was applied to the nine mixtures considered here at atmospheric pressure. The authors (Edmister and Pollock) do not recommend their method for use below atmospheric pressure. Table 5 shows the comparison of the calculated flash slopes, Nelson and Harvey's[6] slopes and Edmister and Pollock's slopes at 760 mm. of mercury for the nine mixtures.

Figure 4 shows the comparison at atmospheric pressure of Nelson and Harvey's slope correlation, those obtained by using Edmister and Pollock's method of evaluating the equi-

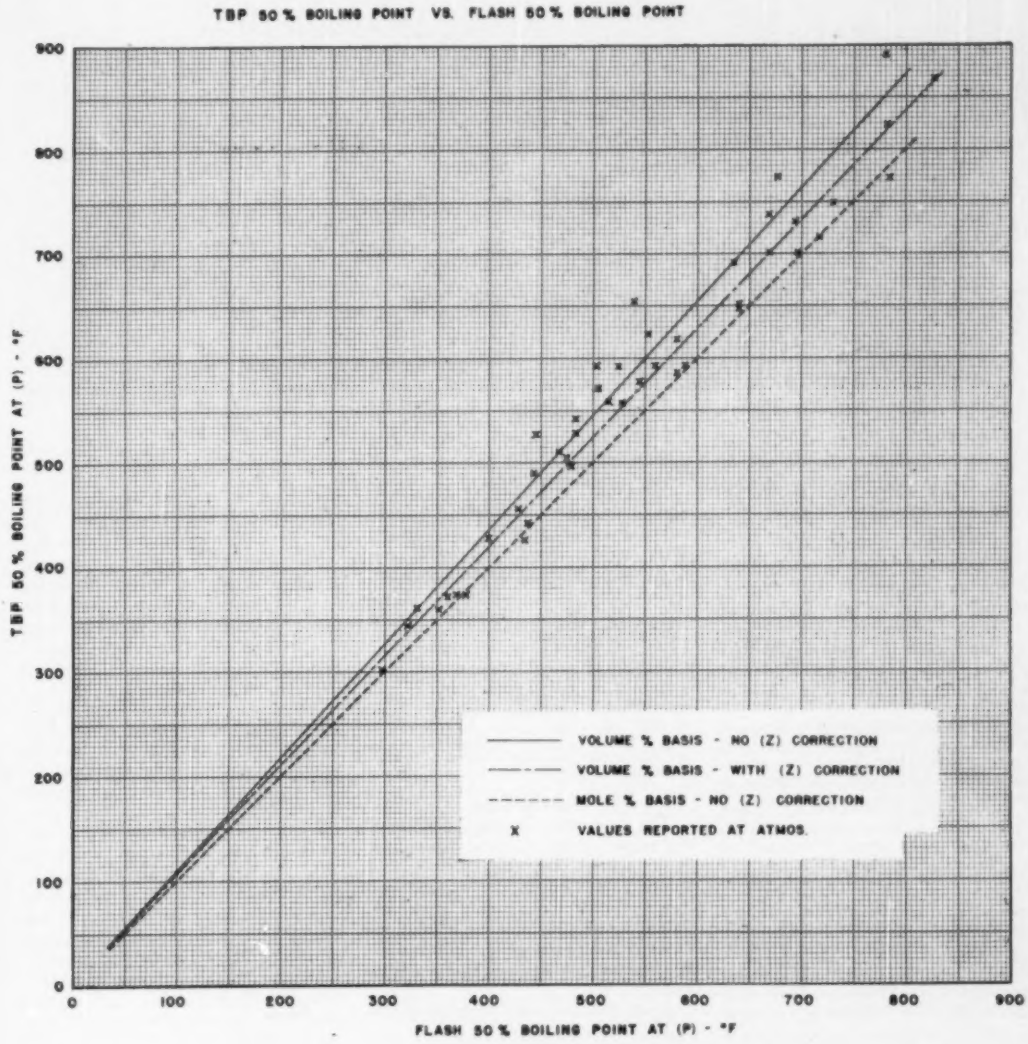

FIGURE 3

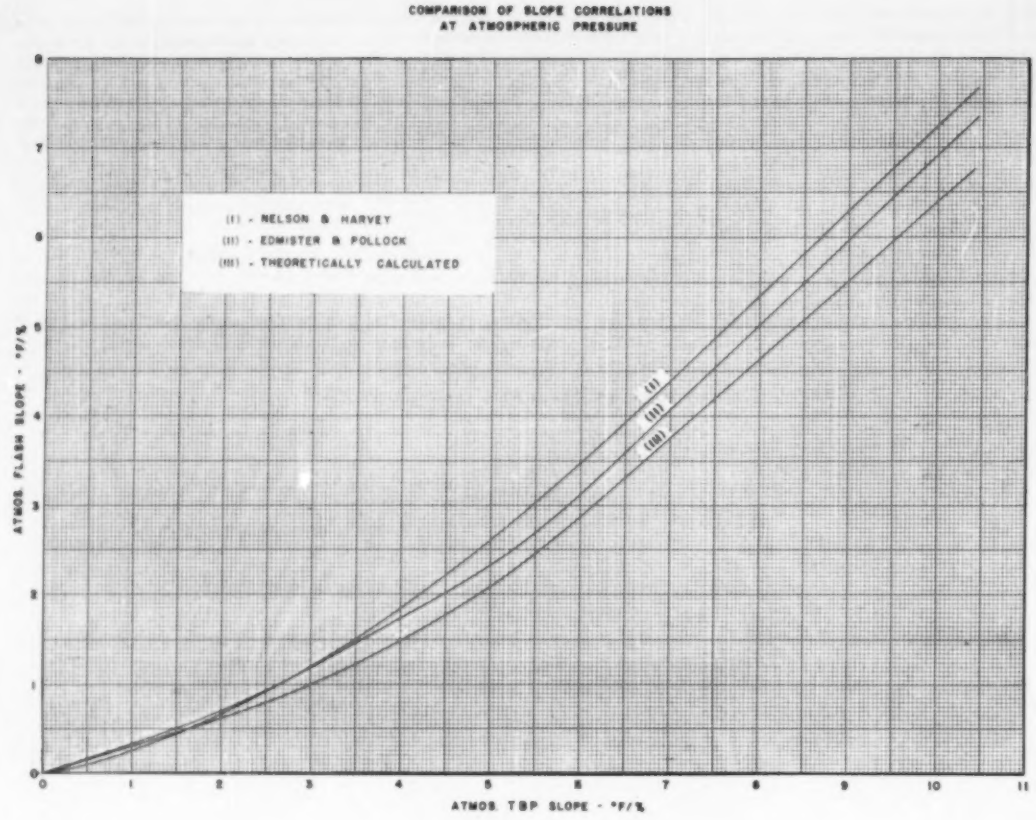

FIGURE 4

librium flash curves and the results of this investigation.

Example Calculation

1) A 38° API Mid-Continent crude oil has an atmospheric TBP 50 percent temperature = 560° F., and atmospheric TBP slope = 6.20° F./percent. Determine the equilibrium flash 50 percent, dew point and bubble point temperatures at 100 mm. of mercury.

Solution:

Equilibrium flash slope at 760 mm = 3.175° F./percent (Figure 1). Refer to Figure 2. Find 560° F. on the atmospheric TBP. 50 percent temperature on the left hand ordinate. Move horizontally to the right until the 100 mm. isobar is reached. Move vertically to the "slope index line." Then move horizontally to the right hand ordinate and read the equilibrium flash 50 percent temperature at 100 mm. pressure.

Equilibrium flash 50 percent temperature = 395° F. at 100 mm. (Figure 2) Assuming a straight line equilibrium flash curve. Dew point temperature = 395 + 3.175 (50) = 554° F. at 100 mm. Bubble point temperature = 395 — 3.175 (50) = 236° F. at 100 mm.

2) A 25° API reduced crude having an atmospheric TBP. 50 percent temperature = 850° F., atmospheric TBP. slope = 5.00° F./percent is to be vacuum distilled at 50 mm. pressure so that 80 percent of the charge will be vaporized. Determine the vaporizer temperature.

Solution:

Equilibrium flash slope at 50 mm. = 2.25° F/percent (Figure 1). Equilibrium flash 50 percent temperature at 50 mm. = 600° F. (Figure 2). Assuming a straight line equilibrium flash curve. 80 percent vaporized temperature = 600 + 2.25 (30) = 667.5° F.

Conclusions

The assumption of ideal behavior of the vapor phase of petroleum oils at low pressures, i.e., around 10 mm. of mercury, is valid for all practical purposes. However, at higher pressures, 200-400 mm. of mercury, deviations from ideality because of compressibility become greater as the pressure increases.

Ideal solutions can be assumed for petroleum oils in the pressure range considered in this investigation without introducing any appreciable errors.

The correlations presented in Figures 1 and 2 enable the direct determination of vacuum flash vaporization curve characteristics for petroleum oils at any sub-atmospheric pressure from atmospheric pressure analytical true boiling point distillation data.

These correlations are not recommended for determination of the equilibrium flash vaporization curves for those stocks evidencing abnormal distillation curve characteristics such as bright stock naphtha solution.

* * *

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The Basis for Selecting Alloy Cast Irons for the Petroleum Industry

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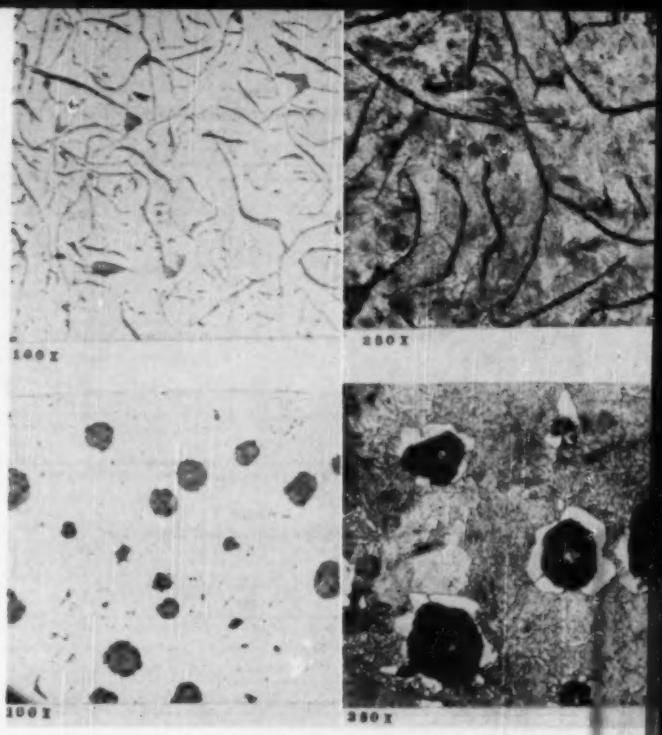


Figure 1. Transformation of gray iron (upper) to ductile cast iron, processed with magnesium (lower), showing the change of graphite from flakes to spheroids.

FOR several hundred years up to about 1920, cast iron was a low tensile strength metal that was easy and cheap to produce. But with the technical advancements that have been made in the last 30 years with the use of alloys, control of foundry practices, etc., the range of properties available today in cast irons has been greatly widened, as exemplified in Table 1.[1]

With a better understanding of the properties of cast iron in service involving metal-to-metal wear, pressure tightness, abrasive wear, thermal stresses, corrosion and heat, engineers now can specify cast irons to meet the ever increasing demands of greater power from engines, higher capacity from pumps, etc., the handling of corrosives, and higher temperatures of furnaces and other industrial equipment.

The mechanical and process engineer cannot hope to keep abreast of the metallurgical developments of cast irons, steels and other special alloys and, therefore, should rely upon regular and constant consultation with those companies and agencies who have the latest information and/or who are skilled in applying the new alloys to industrial equipment.[1]

Special alloy irons or cast irons made to meet particular specifications are acquired from those producers skilled in their production. It is just as impossible for a low grade foundry to supply special purpose irons as it is for a low grade oil refinery to produce the special grades of oils, fuels and petroleum by-products. These special products must be obtained from those producers skilled in their production. The engineer, therefore, is urged to deal only with those foundries whose skill is well established in producing the type of castings specified. Beware, therefore, of trade-named irons unless they can meet the specifications for the service involved.

THE VIEWPOINT of this discussion is to show the wide variety of properties available with alloy cast irons and the special service types of alloy irons such as those registered in the U. S. Patent Office as Ni-Resist and Ni-Hard. The well established uses of alloyed gray irons are not reviewed, but the properties available with modern alloyed cast irons are emphasized and it is shown how these properties can be used to the greatest advantage. Selecting an iron which meets the particular demands for special service in a great industry like the oil industry requires a thorough understanding of both the service conditions and the metal which is expected to operate in that service. It is amazing, the author contends, what economics of procurement and operation can be exercised by the sensible utilization of various alloyed cast irons.

Metal-to-Metal Wear

When specifying cast irons for heavy duty metal-to-metal wear service, it is important to realize that the casting should have the microstructure which assures of optimum wear resistance. It has been found that the optimum wear resistance structure of gray iron is one with AFS Type A graphite and a fully pearlitic matrix. For example, a compressor requiring 40,000-psi. tensile strength iron should be specified to meet ASTM Class 40 strength in the casting and have an AFS-ASTM Type A graphite with a fully pearlitic matrix.[2] Obviously the desired pressure test and/or other additional requirements for the casting should be included in the specification. For light duty parts, the wear properties of all gray irons are good enough and, therefore, do not require specifying the microstructure.

Abrasive Wear

When cast iron is to resist abrasion from ash, sand, abrasive slurries, etc., the highest level of hardness possible should be stipulated. When machining is necessary, the hardness should be of the order of 300 Brinell, which combination of abrasion resistance and machinability is achieved by the use of about 2 percent of nickel and .75

TABLE 1

Range of Properties of Engineering Gray Irons

CLASS	30	40	50	70
Tensile strength, psi. (minimum)	30,000	40,000	50,000	70,000
Transverse strength, load, lb.	2,200	2,600	3,000	3,800
1.2" diameter bar, deflection, in	0.30	0.32	0.34	0.38
Compressive strength, psi.	105,000	125,000	150,000	200,000
Torsional strength, psi.	40,000	54,000	67,000	88,000
Modulus of elasticity,[1] psi. x 10-6	14	16	18	20
Torsional modulus, psi. x 10-6	...	5.5	7.0	8.1
Impact strength, Izod AB (1.2" dia. unnotched) ft. lb.	22	31	68	120+
Brinell hardness	160	220	240	280
Endurance Limit psi.:				
Smooth	15,500	19,500	23,500	29,500
Notched	(12,500)[2]	17,500	21,500	25,500
Damping capacity	Excellent	Excellent	Good	Fair
Machinability	Excellent	Excellent	Good	Fair
Wear resistance	Fair	Good	Excellent	Excellent
Pressure tightness	Fair	Good	Excellent	Excellent
Specific Gravity:				
g per cc	7.02	7.25	7.43	7.51
Lb. per cu. in.	0.254	0.262	0.269	0.272

[1] At 25 percent of tensile strength.

[2] Value estimated.

These properties apply to castings and/or test bars of gray iron that meet the strength class indicated. The relationship of test bar properties and casting properties should be agreed upon between buyer and producer.

TABLE 2

Ni-Hard Composition and Properties*

COMPOSITION

TC	Graphite	Si	Mn	S	P	Ni	Cr
3.0—3.6	.10 max.	.4—.7	.4—.7	.15 max.	.40 max.	4.25—4.75	1.4—3.5

PROPERTIES

	Sand Cast	Chill Cast
Brinell hardness	550—650	600—725
Rockwell hardness	53—61	56—64
Transverse strength, 1.2" diam., lb. (12" span)	4,000—5,000	4,500—6,000
Modulus of elasticity, psi.	25,000,000	25,000,000
Tensile strength, psi. (1.2" diam. test bars	40,000—50,000	50,000—80,000
Izod AB Impact [1], ft. lb.	20—30	25—40
Fracture	White[2]	White[2]

* From "Engineering Properties and Applications of Ni-Hard," a publication of The International Nickel Company, Inc.

[1] 1.2 inches diameter unnotched bar struck 3 inches above support.

[2] Graphite-free.

TABLE 3

Specifications for Gray Iron for Elevated Temperatures

(ASTM A 319—48 T)

		Carbon Equivalent TC + .3 Si			
Increasing Temperature	Class I	3.8—4.4	All three classes may be alloyed with chromium	.30% Cr .55% Cr .80% Cr 1.10% Cr	Nickel, copper, molybdenum or vanadium commonly added to stabilize structure and improve properties
	Class II	3.5—4.1			
	Class III	3.2—3.8			

to 1.0 percent of chromium, with a suitable base chemistry for the iron. For high abrasion resistance and no appreciable machining, the use of nickel and chromium added to white cast iron provides hardnesses of the order of 550-700 Brinell and phenomenal service life against abrasion. This latter type of iron is sold under the trade name "Ni-Hard" and is described in Table 2.

Vibration Damping Capacity and Toughness

Gray iron is brittle and, therefore, would be expected to fail under a low order of impact. In many applications, however, such as crankshafts, the vibrations or impulses imposed can be damped out more readily in gray iron than in most other metals. Our conception of requiring high toughness for crankshafts, for example, is in error, since gray iron crankshafts have proven to give better service life than steel in the same application, in addition to being considerably cheaper than the corresponding steel forgings. Wherever vibrations are inherent in the service of a piece of equipment, the graphite-containing, carefully specified gray iron is quite likely to be better than the tougher, stronger steel.

Ductile Cast Iron

While on the subject of toughness—The International Nickel Company, Inc., has developed a new process[3] for making cast irons with strength and toughness levels in excess of those found in malleable iron and available in castings of both light and heavy sections (see Figure 1). These new irons will offer a cheap and useful substitute for many parts now supplied in steel forgings, castings or rolled products. Their development in industry is moving forward with amazing speed and success. The new process is in production in shops licensed by INCO and involves the addition of magnesium to the iron, resulting in the spheroidal graphite form instead of the well known flake form. This spheroidal graphite form permits the iron to achieve strength and toughnes levels approaching those of steel. It is seen from Figure 2 that the metal dominates the casting properties, since the graphite in the new process iron has a minimum effect on the properties. The flake graphite of conventional gray iron, on the other hand, affords large and many areas of cleavage of the metal, thus materially reducing the mechanical properties.

Ductile Ni-Resist

The new ductile iron process (magnesium treating) when applied to Ni-Resist results in a marked improvement in strength, elongation and toughness. See Table 4. Creep properties of this new type of Ni-Resist are now being investigated in the 1200-1300° F. temperature range. These data will be useful to determine the value of Ductile Ni-Resist in tube supports and other high temperature load carrying parts in the temperature range useful for Ni-Resist. The improved properties of Ductile Ni-Resist in strength and toughness, over those described in Table 4, will afford broad use in both heat and corrosion applications for the versatile alloy Ni-Resist.

High Temperature Service

The War Metallurgy Committee Report Project SP-512[4] showed that gray irons are useful up to 800° F. under load and up to 1000° F. without load. They found that the control of the chemical analysis of the irons profoundly affected the heat resistance. Their recommendations are summarized in Table 3.

It is to be noted that for continued exposures at temperatures in excess of 1000° F., no plain iron and few low alloy gray irons give satisfactory service. The more highly alloyed iron Type 2 Ni-Resist (Table 4) has been found economical and useful in continued high temperature service up to 1300° F. When the temperatures exceed 1300° F., Type 2B or Type 4 Ni-Resist shows satisfactory heat resistance with small load carrying capacity. Table 5 shows some heat re-

sistance data of gray irons and the different types of Ni-Resist.

Plain cast iron has been used in mild corrosive environments for hundreds of years. Its usefulness results from the protection afforded by the impervious film of iron rust and graphite which protects the metal under the surface. The advantage of making gray iron more dense by foundry control and by alloy additions lies in the greater imperviousness to the corrosive action of the environment. It is to be noted also that corrosion data support the contention that, except for the densing effects of alloys and some reduction in graphitic corrosion, no appreciable advantages in corrosion are gained by making 1 to 4 percent of alloy additions to gray irons.

For cast irons with marked corrosion resistance, alloy additions of the order of 10 percent or more of chromium or nickel are necessary. The high chrome types of irons (15 and 25 percent Cr) are limited in corrosion service and have poor machinability. The austenitic nickel types of irons—Ni-Resist—have found wide usefulness in many applications in the petroleum industry handling acids, alkalies, salts, sea water, acid crudes, etc.[5] The superior erosion resistance of Ni-Resist and its excellent metal-to-metal wear resistance provide a unique combination of properties rarely found in one metal. In addition to these properties, thermal shock resistance and controlled expansion, as well as a number of other physical properties, can be selected from one or more of the types of Ni-Resist available (Table 4). Applications utilizing these unique properties available in Ni-Resist are given below.

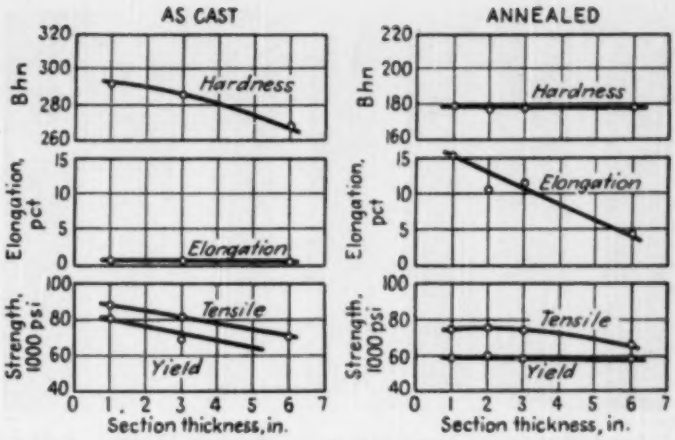


Figure 2. Influence of section thickness on mechanical properties of a magnesium-processed cupola iron containing 3.27 percent C, 2.40 percent Si, 2.01 percent Ni, 0.62 percent Mn, 0.15 percent P, 0.055 percent Mg and 0.010 percent S. The annealed iron was slow cooled from 1700° F., held 5 hours at 1275° F., then air cooled. Modulus of Elasticity . . . 23,000,000 psi.

TABLE 4
Properties of Ni-Resist[1]

TYPE	1	2	2B	3	4	5	Ductile Ni-Resist
Alloy Composition	14 Ni 6 Cu 2 Cr	20 Ni 2 Cr	20 Ni 5 Cr	30 Ni 3 Cr	30 Ni 5 Cr 5 Si	35 Ni	
Tensile strength (thousand psi.)	25—35	25—35	35—45	25—35	25—35	20—25	60—70
Compressive strength (thousand psi.)	100—120	100—120	120—160	100—120	80	80—100	
Yield strength (thousand psi.)							37—40
Elongation (percent in 2 inch)	1—3	1—3					10—20
Modulus of Elasticity (million psi.) (at 25 percent of Tensile strength)	12—14	13—16.2	15—16.5	15—15.5	15	10.5	
Brinell hardness—low chromium	130—160	130—160				100—125	130—170
high chromium			170—250	120—150	150—180		
Toughness by Impact (ft. lbs.)[2]	100	100	60	150	60	130	unbroken
Machinability	Good	Good	Very poor	Good	Fair	Good	
Thermal Expansion (70—400° F.)—(millionths/° F.)	10.7	10.4	10.4	5.35	7.6	2.8	10.5
Magnetic response	Non-Magnetic	Non-Magnetic	Magnetic	Magnetic	Slightly Magnetic	Magnetic	
Creep Stress (psi.) (1000° F., 1 percent Creep—1000 hours)	9,000						

[1] From "Engineering Properties and Applications of Ni-Resist," a publication of The International Nickel Company, Inc.
[2] 1.2 inch abritration bar unnotched—struck 3 inches above supports.

TABLE 5
Heat Resistance Data 1375—1600° F.

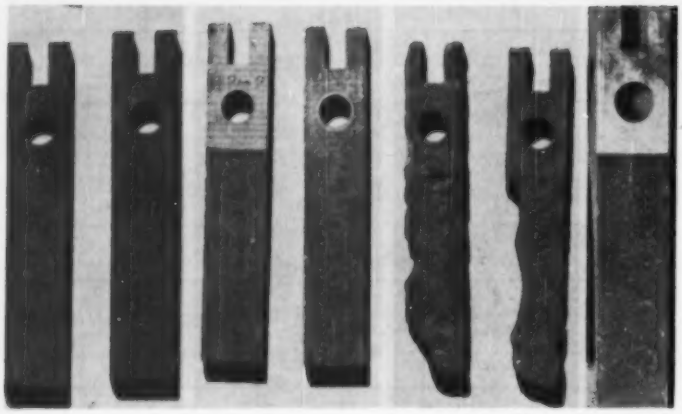
ALLOY COMPOSITION		OXIDE PENETRATION RATES (Inches per Year[1])			
		Test 1	Test 2	Test 3	Test 4
Plain Gray Iron	None		>.8	>1.0	All
Grate Bar Iron	.50 Cr, 1.5 Ni		>.8	>1.0	specimens
Stove Iron	1.0 Cr, 1.0 Ni		.23	>1.0	oxidized
FB-A Iron	.90 Cr, 1.0 Ni		.23	>1.0	after
Type 1 Ni-Resist	14 Ni, 6 Cu, 2 Cr		.18	>1.0	8
Type 2 Ni-Resist	20 Ni, 2 Cr	.27	.16	>1.0	months
Type 2B Ni-Resist	20 Ni, 5 Cr	.006	.07	.12	
Type 3 Ni-Resist	30 Ni, 3 Cr	.078	.09	.37	
Type 4 Ni-Resist	30 Ni, 5 Cr, 5 Si	<.003	.002	.006	.044
25-12 HR Steel	25 Cr, 12 Ni	<.003	0.0	.006	.002

[1] Oxide penetration measured microscopically at 25X.
Test 1—Electric furnace air atmosphere, 1375-1400° F., 3723 hours.
Test 2—Electric furnace air atmosphere, 1400° F., 2000 hours.
Test 3—Gas fire furnace slight reducing atmosphere, 1500-1700° F., 1677 hours.
Test 4—Flue gases from powdered coal with 1.25—2.0 percent S, 1600° F., 10,800 hours (15 months).
All gray iron and Ni-Resist samples, except Type 4, completely oxidized after eight months.

Recent data from the Kure Beach Experiment Station show Ni-Resist to have about five times better erosion resistance than G-Bronze to high velocity sea water (Table 6). Engine liners of Ni-Resist are showing ten to twenty times better wear resistance than good gray iron (Table 7), along with a much higher level of corrosion resistance against the coolants, corrosive products of combustion, etc. Pumps handling hot caustic were cycling in temperatures from the hot caustic at 280° F. to sea water, causing cracking; Type 3 Ni-Resist low expansion pumps have not failed in this service since 1943. The thermal stress analysis is given in Table 8.

Resistance to Corrosion and Abrasion

A new development of the Ni-Resist series is a partially alloyed Type 1 Ni-Resist containing about 8 to 9 percent Ni and 3 to 4 percent Cu, with 2.0 percent Cr, which can be quenched to about 210 to 250 Bhn. (Brinell hardness number) for machining and subsequently hardened by tempering at 1025° F. for 12 to 15 hours, resulting in a hardness of about 500 Bhn. This is being tried in several applications in the petroleum industry where resistance to both abrasion and corrosion is desired. Compared with conventional Type 1 Ni-Resist, this Hardenable Ni-Resist maintains



Type 1, Ni-Resist Type 3, Ni-Resist Gray Iron, 187BHN Modified G-Bronze
(See references to each in the table below.)

TABLE 6

Sea Water Erosion Tests

(Tip velocity 27 fps. Temp. 86° F., Duration 60 days)

	Type 1 Ni-Resist	Type 3 Ni-Resist	Gray Iron (187 Bhn)	Modified G-Bronze
Corrosion rate, ipy[1]	.006	.007	.170	.030
Improvement over gray iron	22.0 X	23.2 X	1.0 X	4.5 X

[1] Inches penetration per year.

about the same corrosion resistance against salts and about one-half the resistance against acids and alkalies as conventional Ni-Resist. Its service is showing useful life in deep well pumps handling corrosive crudes and sand, as well as in surface pumps and valves handling corrosive slurries.

Like all ferrous metals, gray irons, including the highly alloyed austenitic nickel irons, lose a portion of what toughness they have when at —100, —200 or —300° F. There are some cast irons that lose toughness directly as the temperature falls. Some irons undergo a metallurgical change at low temperatures, and with this change there is a marked drop in toughness. Table 9 shows typical values of cast iron toughness as measured by an impact test of a 1.2 inches diameter unnotched bar struck 3 inches above the support. The table also shows how some irons change in metal structure sufficiently to become appreciably harder and stronger at the low temperatures.

Since we are familiar with the successful performance of high duty gray irons with impact values of 35 to 50 foot pounds at room temperature in compressors, engines, pumps, valves, etc., we are anxious that the impact property of such equipment at low temperature remains at least as good as that at room temperatures. It is imperative, of course, when handling pure oxygen, for example, to use equipment that will be especially foolproof because of the fire hazards involved. For this service, therefore, Ni-Resist with its high impact values, little or no metallurgical change at very low temperatures, superior wear and with a selection of expansivities, has been found a useful alloy in low temperature equipment for more than 15 years.

TABLE 7

Ni-Resist in Engine Liner Service

	MATERIAL	Duration of Service	Average Cylinder Wear	Cylinder Corrosion—(Water Side)
1.	Porous Krome Cast Iron	3,000 hours	.008	General corrosion and pitting occasionally through the wall.
	Ni-Resist, Type 2 (160 Bhn.)	2,500 hours	.009	No corrosion, slight discoloration.
2.	Grey Iron (250 Bhn.)	35,000—50,000 mi.	.0075	Bad corrosion with pitting often through cylinder wall.
	Ni-Resist, Type 1 (150—170 Bhn.)	100,000 mi.	0.0015	No appreciable corrosion, slight pitting.
3.	Gray Iron (220 Bhn.)	50,000 mi.	10 to	Standard cylinder block.
	Ni-Resist	50,000 mi.	1	Ni-Resist cylinder insert in gray iron block.
4.	Ni-Resist	2,000 hrs.	.0005	Full liner in aluminum block.

No. 1—Heavy duty truck diesel engine hauling ore from pit.
No. 2—Heavy duty truck diesel engine trailer road service, West Coast.
No. 3—Taxicab and light city bus service.
No. 4—Light duty, high speed engine, air-cooled.

TABLE 8

Maximum Thermal Stresses in Rigidly Designed Structures Caused by Sudden Temperature Changes

MATERIAL	Service Conditions	Expansion Strain (In./In.)	Stresses
Plain Cast Iron	Between 100 lb. steam (338° F.) and tap water at 70° F.	.00188	22,000 psi.
Types 1 and 2 Ni-Resist		.00287	34,000 psi.
Type 3 Ni-Resist (30 percent Ni)		.00134	19,000 psi.
Minovar (35 percent Ni)		.000855	12,000 psi.
Plain Iron	Between 250° F. and tap water at 60° F.	.00127	15,000 psi.
Types 1 and 2 Ni-Resist		.00199	24,000 psi.
Type 3 Ni-Resist (30 percent Ni)		.00095	12,000 psi.
Minovar (35 percent Ni)		.00049	7,500 psi.

Examples of Specifying Cast Irons

From the data on cast iron properties, it is obvious that a wide range of service conditions can be met by a suitable specification of the alloyed cast iron designed to meet these demands. Examples of specifying cast irons are included to illustrate the use of established data on modern cast irons applied to the petroleum industry as follows:

1) *Draw work engine cylinders,* whether for diesel or steam service, require metal-to-metal wear resistance at an assumed strength level of say 35,000 psi. Specification: Class 35 gray iron, hardness 190-220 Brinell, and Type A graphite (AFS).

The minimum hardness and Type A graphite are to assure of optimum wear resistance; the maximum Bhn. is to assure of good machinability. The foundry will select the suitable alloy analysis for the iron to meet the specifications.

Cylinders requiring corrosion resistance to combustion products or to cooling waters, as well as wear resistance, should be specified in Type 1 or 2 Ni-Resist in the 135 to 170 Brinell hardness range. This alloy iron has unusually good wear resistance along with its characteristic corrosion resistance.

2) *Oil well bottom hole pumps* require resistance to sand abrasion only when handling a sweet crude. Specify

TABLE 9

Low Temperature Properties of Cast Irons and Ni-Resist

	Room Temperature		−100° F.		−310° F.	
	Impact[1]	BHN	Impact[1]	BHN[2]	Impact[1]	BHN[2]
Plain Cast Iron	28	210	23	210	16	230
Ni C.I., 2.3 percent Ni	38	255	22	255	19	255
Ni-Cr C.I., 2.5 Ni, .54 Cr	32	255	24	255	18	260
Ni-Mo C.I., 1.5 Ni, .47 Mo	56	280	64	297	28	302
Ni-Mo C.I., 1.75 Ni, .75 Mo	57	320	63	320	36	390
Type 1 Ni-Resist	100	142	100	148	90	161
Type 2 Ni-Resist	120+	133	120+	137	91	194
Type 3 Ni-Resist	115	144	76	144	74	144
Type 4 Ni-Resist	84	185	79	185	77	187

[1] Izod impact on 1.2 inch diameter unnotched bar struck 3 inches above support.

[2] Increase in hardness at low temperatures indicates structure change. All Bhn. determinations at room temperature after cooling treatment.

Ni-Hard cylinders and pistons. Sour crude wells require resistance to both sand abrasion and corrosion. Specify Hardenable Ni-Resist, which has about the same corrosion resistance as regular Ni-Resist and is supplied at about 500 Bhn. for abrasion resistance. The indications are that this metal is doing very well in this service.

3) *Salt water pumps and lines,* whether in deep wells or handling sea water; Ni-Resist pumps should be specified, since they have indicated marked superiority over cast iron and most bronzes in sea water and brine service.

4) *Natural gas compressors;* resistance to corrosion and metal-to-metal wear. Specify Type 1 or 2 Ni-Resist. Gas engine cylinders should be specified in the same way as the cylinders in No. 1. When burning sour gas, the engine cylinders should be specified in Type 1 or 2 Ni-Resist.

5) *Pumps, valves, headers, cooling sections, etc.,* for natural gasoline plants and general refinery use, can be supplied in gray iron for temperatures up to 450° and where there is no corrosion problem. For corrosive media, Ni-Resist offers excellent service and it may be applied in steam and corrosion service up to 600° F. Hot oil pumps frequently are lined with Type 3 Ni-Resist to meet the corrosion and wear and still have the same expansivity as the steel body at the service temperatures.

6) *Sea water pipe lines, coolers, condensers, pumps, etc.* Types 1 and 3 Ni-Resist have shown economical superiority over gray iron and most bronzes and very superior service life under high velocity erosive conditions.

7) *Acid sludge lines, pumps, etc., or for reducing types of corrosives.* The erosion resistance of Ni-Resist with acids, alkalies and salts offers good economical service where gray iron is inadequate.

8) *Coke handling and pulverizing equipment.* For abrasion resistance, Ni-Hard with its high hardness offers the best alloy iron for this service and has a long and successful record handling and grinding coke, sand, etc.

9) *Dewaxing filters, pumps, compressors, etc.* Maintenance of good cast iron properties at sub-zero temperatures is essential. Like all ferrous metals, cast irons become more brittle as the temperature falls. For dewaxing temperatures, —50 to —75° F., Table 9 indicates that nickel-molybdenum irons and the various types of Ni-Resist offer the greatest assurance of good properties at sub-zero temperatures.

Summary

The various types of modern cast irons offer a wide variety of properties that the design, production and maintenance engineers would do well to utilize. It is urged, therefore, that the engineer maintain contacts with those agencies, specialty foundries and metal specialists who can advise on and/or supply the particular irons needed. Not all foundries can supply specialty irons, but neither can all restaurants serve really good steak dinners. The most progressive foundries collectively can supply the iron castings the petroleum industry needs. The engineer, therefore, should rely on those casting producers who have good reputations for quality products and who are familiar with meeting exact specifications.

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[3] "Ductile Cast Iron," by A. P. Gagnebin, K. D. Millis and N. B. Pilling, *Iron Age,* Feb. '48.

[4] "Increased Use of Gray Iron in High Temperature Operations," by C. O. Burgess and T. E. Barlow, A.F.A. Trans. Vol. 53, 1945, pp. 283-291.

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Discussion

T. E. EAGAN

Chief Metallurgist

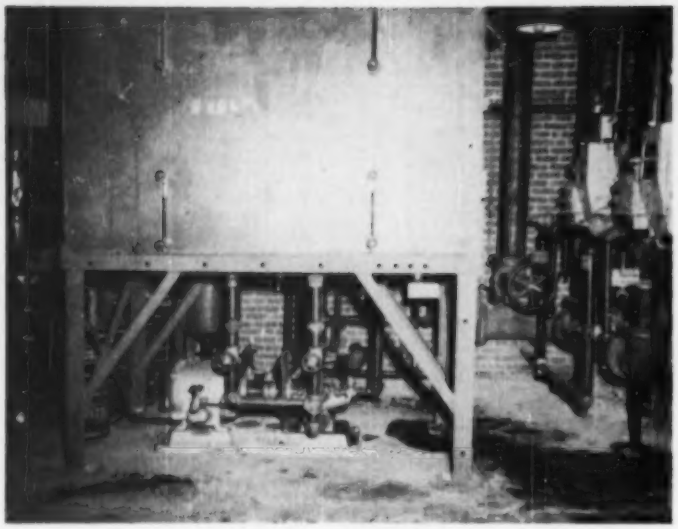
The Cooper-Bessemer Corporation

IN THE interest of briefness, the author has been forced to exclude many important considerations, some of which need further comment.

The physical properties of gray iron castings vary, dependent on the section thickness, the methods of molding, and the chemical analysis of the metal. In order to give the designer some information as to the physical properties obtainable, it is necessary that we use some arbitrary standard such as the ASTM 1.2-inch diameter arbitration bar for the presentation of such data. This is what the author has done in Table One. Having these figures, the designed can allow for the normal variances that he would obtain in the casting proper. This does not mean that the designer is limited in using the physical properties obtainable in gray iron; but, in order to do so, he must work closely with the foundryman. For instance, if the designer wants to have 50,000 psi. tensile strength in a casting, he can have it by informing any good foundryman that he wants it. The foundryman will then choose the proper metal to [illegible] the desired tensile strength. The test bar, however, will have perhaps 60,000 psi. for castings with heavy sections and perhaps below 50,000 psi. for thinner sectioned castings. In important castings it may be necessary to establish the correlation between the casting and the test bar by destroying one casting and taking test bars out of it. For most castings, however, this is not necessary because a reasonable correlation between the test bar and the casting has been established. There is no need for the designer to be afraid to use gray iron if he will cooperate with the foundryman in producing what he wants.

It has been established beyond much doubt that gray iron properly made is one of the best wear resistant materials. The emphasis that the author gives to the microstructure and Brinell hardness requirements for a good wearing iron is well done. Without the fulfillment of these requirements, gray iron can give very poor results; however, if the design is such that there is poor lubrication or poor cooling, the wear results will be poor. To get the optimum wear resistance the design of the particular part must be correct. For instance, with a certain four cycle diesel engine, an optimum wear resistance of approximately .001 inches per thousand hours was obtained by controlling the microstructure of the metal in the liner. By changing the design so that the cooling of the top ring belt was more efficient, the wear resistance was improved to between .0002 to .0005 inches per thousand hours, depending on how well the operator took care of his engine temperatures and lubricating oil.

The author recommends the use of "Ni-Resist" for engines using sour gas for fuel. This recommendation is based on the superior corrosion resistance of this type of material. There are, however, many, many cylinders now in use in engines burning sour gas which are giving excellent wear resistance, the composition of which is nothing more than a Class 40 gray iron with no alloy additions. Economically, the use of "Ni-Resist" would not be warranted for these cylinders. Under perhaps adverse operating conditions and poor design, the use of this material may be warranted, but to prescribe it as a panacea for all the troubles experienced with wear resistance may be economically dangerous.



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Foam Liquid Storage Tank and Injection Pump

"Bean Soup" of Navy Fame Applied to Industrial Plants

FOR many years fire protection engineers have been using a chemically formed blanket of carbon dioxide bubbles for the extinguishment of fires in flammable liquid storage tanks and similar hazards. This chemical foam, although an excellent extinguishing agent, has been limited in scope of protection through a lack of adaptability to simplified system design.

Shortly before World War II, a new substance was developed which was considerably more adaptable than chemical foam. The formation of foam by this new method was radically different from chemical foam in that it consisted of a mass of mechanically formed air bubbles in place of chemically formed CO_2 bubbles. Advantages in the handling and usage of this material were apparent to our military services who used most of the U.S. output through the war period. Huge quantities were used by the Navy where it became popularly known as "bean soup."

Of several materials used to produce mechanical foam, one popular and stable material is a hydrolyzed protein manufactured from a soya bean base. This material when mixed six percent by volume with water and aerated forms a homogeneous tenacious foam blanket capable of flowing around obstacles and quickly extinguishing fires involving gasoline, benzol, naphtha and many other flammable liquids.

One example of the use of this material for fire protection is shown in the series of photographs here. The basic problem at this plant was the control and isolation of a spill fire which might occur at tank car unloading locations and flammable liquid storage tanks on a railroad spur. Flammable materials in-

Photo No. 1. Heat test is applied to heat actuated device at beginning of full scale test. (Foam liquid from test, 18 hours earlier has practically dissipated without clean up operations.)

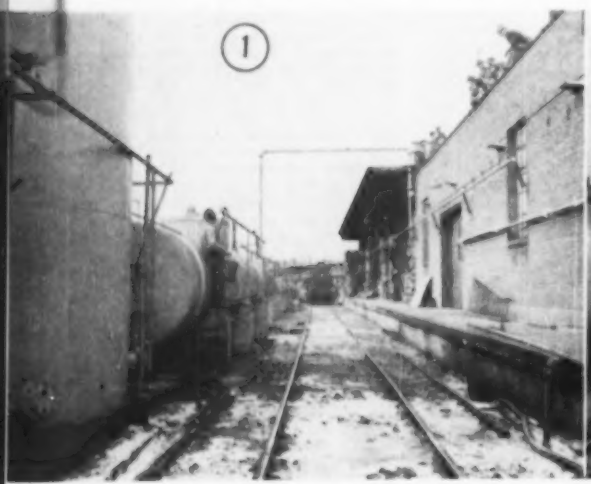
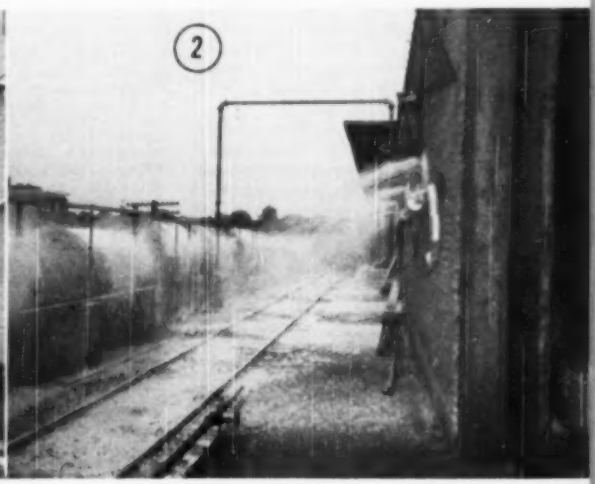


Photo No. 2. Test, Approximately 18 Seconds Later.



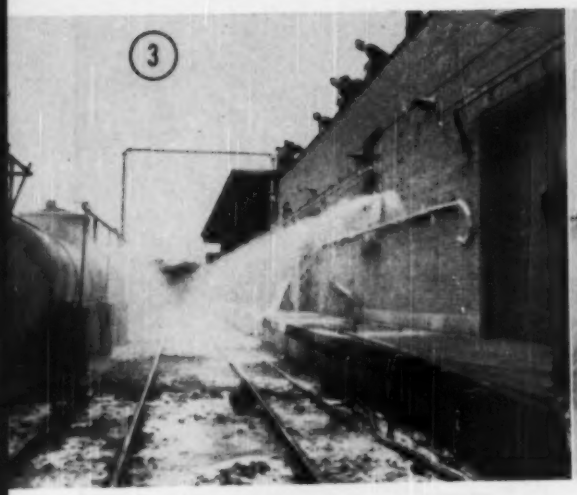


Photo No. 3. Test. One Minute Later.

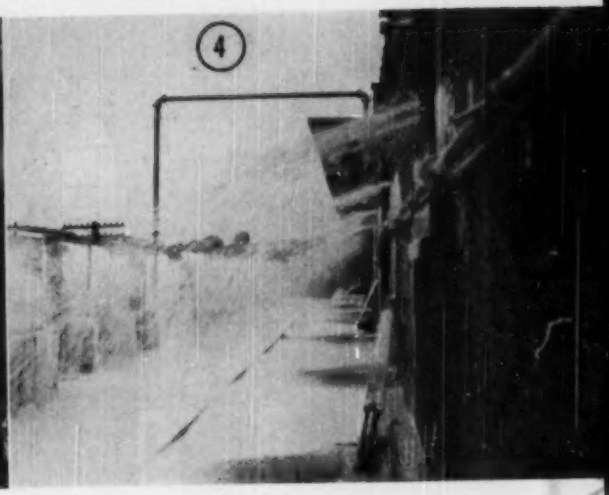


Photo No. 4. Test. Two Minutes Later.

cluding naphtha and benzol are stored and handled here. This area is practically inaccessible to city fire department operations.

The area protected varies in width between 25 and 40 feet and is about 450 feet long. It is divided into three system areas. Protection for each area is regulated by an individual valve, actuated pneumatically by pressure impulse from pneumatic heat detectors strategically located throughout the areas protected by each system. A deluge sprinkler system operation is employed. Each piping system is equipped with 16 or 17 overhead foam aerating and discharge devices. The discharge pressure at these devices is about 75 psi. giving a total foam discharge of about 8800 gpm. per system. These systems are equipped with alarm gongs, supervisory features and other types of devices required for approved sprinkler systems.

The foam storage and injection system consists of a small foam injection pump which takes suction from a double-compartmented, 800-gallon, foam-liquid storage tank. It provides for the discharge of foam liquid into a piping system which distributes the foam liquid to the three systems and to nine portable hose stations located within the plant. One side of the foam liquid storage tank is always open as suction to the foam liquid pump. The other side of the storage tank is kept closed so that the system may be immediately returned to service following use. Metering of the foam liquid into the water piping system is accomplished by means of orifices. The foam liquid operation is supervised by a 50-gallon cushion tank which will supply several minutes of foam operation to the portable units within the plant before the foam liquid pump cuts in from low pressure.

When mixed with water and aerated, the foam liquid in one compartment of the storage tank will form 58,000 gallons of smothering mechanical foam or a total of 116,000 gallons is available through the utilization of the entire storage of foam liquid.

Foam coverage from the systems is at a rate of about two inches of depth per minute. Somewhat more than 7½ minutes supply of foam liquid is available from each section of the foam storage tank. In general, with the foam liquid presently available for the systems, the entire area could be covered with two foam blankets of about six inches in depth.

Aside from standard nozzles at each portable hose station location, special goose-neck applicators are provided for the extinguishment of any fire which might occur in the vertical storage tanks.

(Editor's Note—Material and photographs through courtesy "Automatic" Sprinkler Corporation of America, Youngstown, Ohio.)

Photo No. 5. Test. After Three Minutes of Operation. (Note complete coverage and depth.)

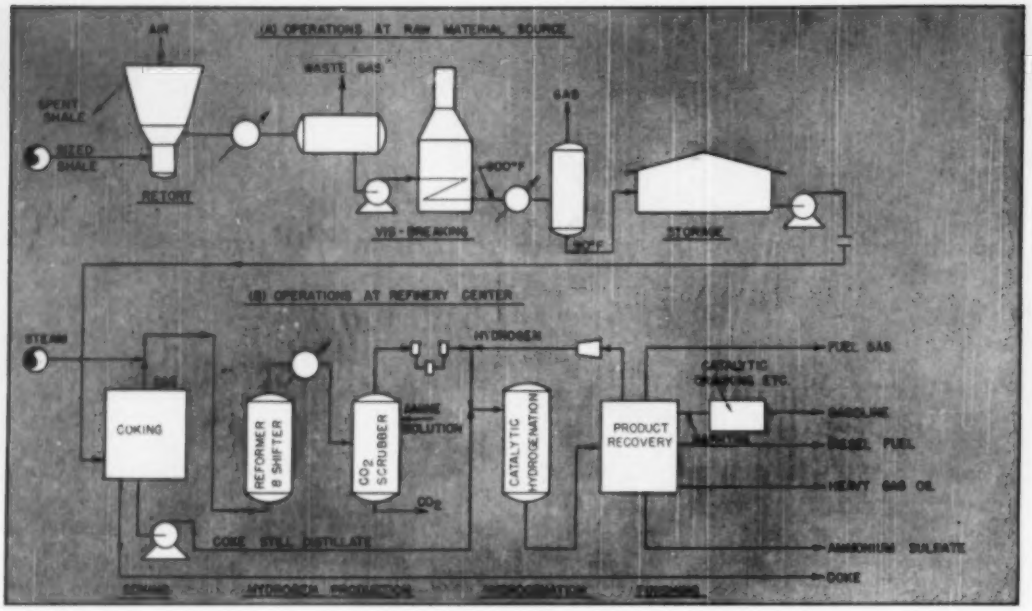


Figure 1. Liquid Fuels from Oil Shale.

Liquid Fuels from Coal and Oil Shale

GEORGE ROBERTS, JR. and PAUL R. SCHULTZ
Stanolind Oil and Gas Company, Tulsa

THE three important raw materials that can be used to supplement or replace crude petroleum as sources for liquid fuels are natural gas, oil shale, and coal. Of these, natural gas is the least important because of limited availability. It is finding a profitable and essential market as domestic and industrial fuel, and the reserves in excess of these applications could provide only a few percent of the demand for liquid fuels. Although of minor importance from the standpoint of potential volume, the development of synthetic liquid fuels from natural gas has led industrial research efforts in the synthesis field since it appeared to be the most economically attractive of all the synthesis processes.

The production of liquid fuels from coal and shale has been developed on a commercial scale in numerous foreign countries, particularly Germany. However, because processes as developed abroad are financially unattractive in the American economy, they are of little interest in this discussion. The synthesis of liquid fuels from natural gas has not been practiced in foreign countries, but this process is now nearing commercialization in the United States.

In order to evaluate the comparative economics of liquid fuels from coal and oil shale, it was necessary to postulate representative cases, formulate workable plant designs, and estimate investment and operating costs for each case. Three basic cases were selected, one on oil shale, one on bituminous coal, and one on subbituminous coal. Nominal capacity of each plant was fixed at 10,000 barrels daily. Locations were selected after consideration of the critical economic factors: raw material supply, labor, water, and existing transportation facilities. Final product costs were debited with transportation charges to reflect product distribution in a common market.

The designs were developed on a conservative basis. Known processes of definite operability were utilized to the fullest extent. When proved processes were not available, the results of research were employed to devise a process with maximum assurance of operability.

Oil Shale

It has been estimated that at least 100 billion barrels of oil can be obtained from known U. S. shale deposits.[1] The recovery of oil from shale is a commendable conservation measure since oil shales in their natural state are not useful as fuels like coal and natural gas.

Production of liquid fuels from oil shale may be divided into two basic operations: a) the mining of the shale and recovery of the crude shale oil and b) refining of the crude oil. In the U. S., the Bureau of Mines is actively investigating all phases of the operations. Some industrial concerns are studying the retorting operation and refining the crude oil.

Investigations on mining by the Bureau of Mines at Rifle, Colo., have indicated that oil shale in that region can be mined at a cost of about 60 cents per ton by "underground quarry"

techniques.[2] Conventional conveying equipment can be used to transport the shale to a nearby retorting site.

For the retorting of oil shale, several methods have been proposed, and some experimental work has been performed. The methods include NTU retorts, fluid bed operations, Thermofor kiln, and the Union Oil Company's upflow retort.[3] The Union type was selected as a basis for this study since it is continuous in operation, relatively simple, and requires a minimum of cooling water. It is a large cylindrical vessel into which the crushed shale is introduced by an under feed stoker device. The shale passes upward through the vessel and is discharged as ash at the top. Air enters at the top, is preheated by the effluent ash, burns the residual coke in the spent shale, and carries heat into the raw shale for removing the crude shale oil. The vapors from the distillation zone are cooled while heating the incoming shale, and the make gas and condensed oil are withdrawn near the bottom of the vessel.

Refining the crude shale oil into products competitive with those from petroleum is a major problem. Shale oil is rich in olefinic and ring compounds and has troublesome contents of nitrogen, sulfur, and oxygen.[4] It is also too deficient in hydrogen to respond well to cracking. However, a preliminary coking operation can remove some sulfur with the coke, and the coke still distillate can be hydrogenated to yield a product that is amenable to finishing by conventional methods.[5]

Figure 1 shows the flow for shale oil processing. Oil shale, assaying 30 gallons of "oil" per ton, is assumed to be mined in the region near Rifle, Colo., using the Bureau of Mines Techniques. After crushing at the mine, it is transported by conveyor to a nearby retorting site where the oil content is recovered in Union-type upflow retorts. The crude shale oil is vis-broken in order to reduce pour point and viscosity sufficiently to permit pipe-line transportation to a refinery near its potential market (in this study considered to be Chicago). Extensive refining near the shale oil deposits would be impractical because of the unavailability of labor and lack of adequate water supplies.

At the Chicago refinery the vis-broken shale oil is subjected to a preliminary coking operation. The coke still distillate is hydrogenated catalytically, and the resulting product is finished into marketable fuels by conventional refinery techniques. Hydrogen for the hydrogenation operation is obtained by reforming and water-gas shift conversions of the fuel gas produced from the coking and other units.

Process yields and costs associated with recovery and refining of shale oil are discussed under the heading "Economic Comparisons."

Coal

For the long-term future, coal is the most important raw material for synthetic fuels. Although the U. S. coal reserves are probably far less than the estimate prepared by the U. S. Geological Survey in 1906, undoubtedly tremendous quantities exist. This is particularly true of the lower rank Western coals, subbituminous and lignite. Because of their location and their physical properties, these two grades of coal find little demand today. Certain grades of Eastern coal, such as anthracite and the bituminous grades suitable for making metallurgical coke, can be exempted from use for synthetic fuel production because of their scarcity.

Synthetic liquid fuels can be produced from coal by either the Bergius hydrogenation process or the Fischer-Tropsch synthesis reaction. The data on recent developments in coal hydrogenation are confined, primarily, to Bureau of Mines publications.[2,6] There has been little published in recent years regarding the work of private industry in this field. Hydrogenation appears somewhat less economic than the Fischer-Tropsch process. Consequently, this discussion will not include coal hydrogenation as a competitive alternate process.

The Fischer-Tropsch process is applicable to either coal or natural gas as raw materials and consists of two fundamental operations: a) conversion of the raw material to a synthesis gas consisting principally of carbon monoxide and hydrogen, and b) reaction of this gas over a suitable catalyst to produce hydrocarbons. Synthesis gas made from coal normally has a hydrogen-carbon monoxide ratio of about 1:1, while synthesis gas produced from natural gas has a hydrogen-carbon monoxide ratio of 1.8:1. This difference in gas composition has a pronounced effect on the subsequent synthesis reaction. By using a water-gas shift, it is of course, possible to upgrade low H_2:CO ratio gas from coal so that it corresponds to synthesis gas from natural gas.

German commercial plants utilized coal or coke as raw material. For the gasification of solid fuels, several types of generators were developed; e.g., the Lurgi (elevated pressure) and the Winkler (low pressure). The work in this country on synthesis gas generation from coal has included proposed modifications of the Lurgi and Winkler types, dilute-phase (pulverized coal) generators, and fluid carbonizers and gasifiers. The Bureau of Mines is investigating two types of dilute-phase reactors, the simple vortex burner and the Koppers generator. Others are investigating fluid-bed carbonization of coal to yield fuel gas and fluid-bed gasification of coal or coke to produce synthesis feed gas. All of these are alternate methods to obtain reaction of coal or coke with oxygen and superheated steam yielding carbon monoxide and hydrogen as primary products.

German commercial practice has been based entirely on low H_2:CO ratio gas made from coal or coke. The synthesis process typically uses a cobalt-thoria catalyst in fixed beds, with the heat of reaction removed by oil or water circulating through a multitude of tubes traversing the catalyst beds. The chief disadvantages of the German process are a) low-pressure operation which necessitated large reactor volumes, b) use of expensive cobalt-thoria catalyst, c) poor heat removal because of the fixed beds, and d) the production of heavy saturated hydrocarbons having low value as motor fuel.

In this country, work on synthesis of low H_2:CO ratio gas has been carried out primarily by the Bureau of Mines. Two types of reactors have been tested experimentally using iron catalyst. In the internally cooled type, the catalyst is in the form of pellets in a fixed bed. A heavy oil is circulated through the bed to transfer heat of reaction from the catalyst to tubes through which a cooling medium is passed. The second or slurry-type reactor utilizes a catalyst suspended in a heavy oil, and the reaction temperature is controlled by circulating the slurry through external heat exchangers for cooling.

On the other hand, industrial research and development in the U. S. on the Fischer-Tropsch synthesis has been chiefly concerned with its adaptation to high H_2:CO ratio synthesis gas obtained by partial oxidation of natural gas with oxygen. This gas is then reacted over an iron catalyst in a fluidized bed to form hydrocarbons and oxygenated derivatives, with some waste carbon dioxide and water. The hydrocarbons are recovered by conventional methods. After catalytic treatment under mild cracking conditions (isoforming) which also converts the accompanying oxygenated compounds to olefins, these hydrocarbons are separated into gasoline, distillate fuel, and residual fuel. This synthesis process is conducted at pressures up to 500 psi., has vastly improved heat transfer characteristics as compared to fixed-bed processes, uti-

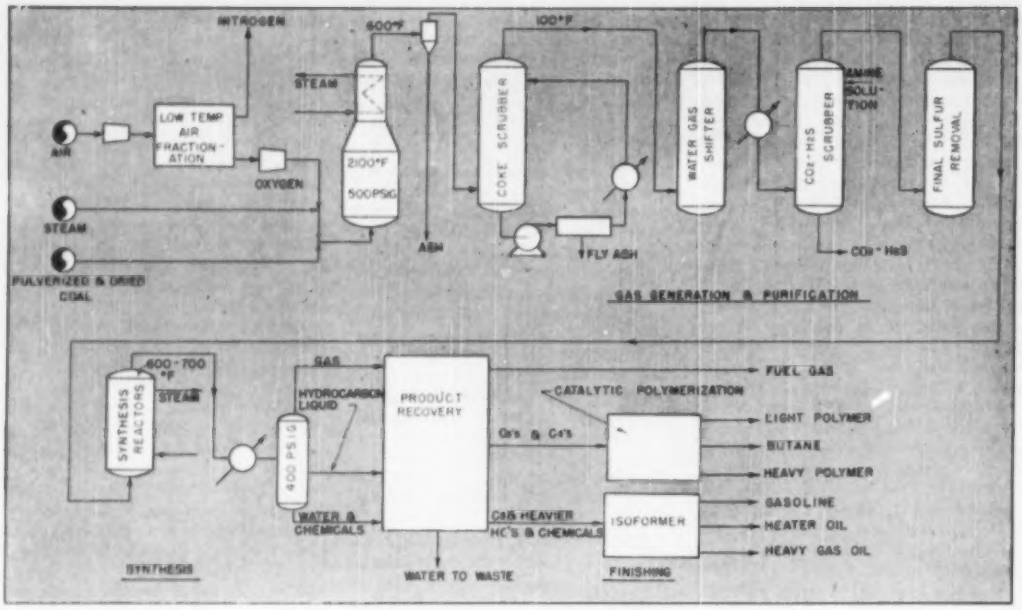


Figure 2. Synthetic Fuels from Liquid Coal

lizes a cheap catalyst, and produces a high yield of quality gasoline.

Little work has been done on application of fluid-type reactors to low H_2:CO ratio gas, such as may be obtained from coal gasification. Since the fluid-type reactor is considered superior to the fixed bed for this reaction, it was employed for purposes of this study. As a consequence, the water-gas shift to obtain higher ratio gas was included in the process design and the economics.

Recovery and finishing of the products from the synthesis reaction based on gas from coal have not been intensively investigated in this country. However, the operations developed in connection with synthesis from natural gas should be directly applicable.

The basic process flow for the coal plants is shown in Figure 2, although separate designs were made for the bituminous and subbituminous coal cases. The coal, mined and delivered to the plant site, is pulverized and reacted in a fluid bed with oxygen and steam at elevated pressure. The resultant gas has a H_2:CO ratio of approximately 0.8 and is reacted with steam over a water-gas shift catalyst to yield a H_2:CO ratio of 1.8. After removal of carbon dioxide and sulfur compounds, the process flow is similar to that developed for a plant using natural gas. The synthesis gas is reacted over a fluid iron catalyst, and the reaction products are separated. A portion of the off gas is recycled to the reactor while the net make is passed through a conventional oil absorption system to recover the liquid hydrocarbons. The liquid fraction, combined with the debutanized stream from the vapor recovery system, is isoformed to improve octane rating and to convert the oxygenated compounds to the corresponding olefins, and is fractionated into conventional cuts. The propylene and butylene recovered in the absorption system are catalytically polymerized to yield polymer gasoline.

Since this study is concentrated on liquid fuels, neglecting by-product chemicals, the product water from the reactor is subjected to distillation to concentrate the water-soluble chemicals as a distillate. This fraction is passed through the isoformer to convert the oxygenated materials into olefins and augment the hydrocarbon yields.

Economic Comparisons

A study of the economics of liquid fuels from coal and oil shale would have little meaning without an index for comparison. Consequently, a base case for fuels from Wyoming heavy crude was developed. This oil was chosen as the least desirable of current crudes and the first increment of crude production which could be replaced by other sources of liquid fuels. A case utilizing Gulf Coast natural gas as a synthesis raw material was also developed.

In evaluating various raw materials as sources for liquid fuels, a number of important factors must be considered. Transportation charges are important in the costs of the finished product, and it was elected to develop cost data for all cases on the basis of a market centered at Chicago.

Choice of raw material source is likewise of considerable economic significance and was carefully made. Selection of a source of oil shale falls rather obviously to the region near Rifle, Colo., with the shale oil refinery located at Chicago. For the bituminous coal case, a location near Vincennes, Ind., was chosen as combining adequate coal deposits, water, suitable labor supply, and rail transportation facilities. In the case of subbituminous coal, however, selection of a plant site was not so easy, and it was finally necessary to compromise on a location near Miles City, Mont. Water, labor supply, and rail facilities are adequate at this location, but the coal must be brought to the site by means of a 60-mile conveyor system.

From the standpoint of process design, the principal difference between the subbituminous and bituminous cases is the disposition of make (fuel) gas in excess of plant requirements. In the bituminous coal case, it is assumed that this gas could be marketed in the immediate area (Southern Indiana) as industrial fuel. In the subbituminous coal case, no market disposal appeared feasible, so the excess

is returned to the synthesis gas generator for reconversion to carbon monoxide and hydrogen. This procedure decreases the coal requirements per barrel of liquid products but does involve reprocessing of synthesized hydrocarbon gases. Another difference in these two cases is that the bituminous coal case contemplates underground mining while the subbituminous coal case employs strip mining.

Summary material balances for all cases are given in Table 1. It may be noted that the coal requirements per barrel of liquid product are virtually the same for bituminous and subbituminous coal. However, the bituminous coal has a net production of by-product fuel gas amounting to 0.68 barrels of fuel oil equivalent. The subbituminous coal case is in fuel balance and does not have this by-product.

Cost estimates were made for each of these designs based on high engineering standards. All utilities and facilities in addition to process equipment were included. In this connection, useful indices were obtained from the definitive cost estimates prepared for the Stanolind Hugoton project for synthesis of liquid fuels from natural gas. Where applicable, raw material mining and transportation investments were included. Product transportation investments necessary to serve a common marketing area were also estimated.

A comparison of investment costs is given in Table 2. These costs are expressed in dollars per daily barrel of equivalent gasoline. Equivalent gasoline is defined as 100 percent of the gasoline yield plus 70 percent of the distillate fuels, plus 40 percent of the residual fuel. This method adjusts different products to a comparable basis.

The investment costs for Wyoming crude and natural gas include the producing facilities. The large difference shown in this item ($6800 per daily barrel vs. $300) is caused by the apportionment of exploration costs, dry hole expenses, etc., which are normally charged entirely to crude petroleum operations. Also, the drilling and gathering charges for natural gas are minimized because of the large deliverability of individual wells in the Gulf Coast area. These items of investment are shown for comparative purposes but were not used in the preparation of final product costs since crude and natural gas were assumed to have been purchased at a market price.

The comparative raw material costs are given in Table 3. In the costs for shale and coal, all items of expense including management, overhead, royalties and production and property taxes were considered. The price of $2.09 per barrel for Wyoming crude is based on a posted price of $2.04 for 28° API gravity and a gathering charge of $0.05 per barrel. The price of 12c per mscf. for natural gas is representative of the average price which might be obtained under a long-term contract for Gulf Coast natural gas gathered to a central point. Although the Bureau of Mines estimate for shale mining amounted to 60 cents per ton, this study yielded 80 cents per ton direct cost and 99 cents per ton with 14 percent charges on investment.

The estimated costs of liquid fuels derived from these raw materials are shown in terms of equivalent gasoline in Table 4. It will be noted that direct costs are separated into several categories. The raw material cost was obtained from the values shown in Table 3. Raw material transportation includes the cost of moving the raw material from a central point at the source to the processing site. For the oil shale case, however, the cost of transporting the vis-broken shale oil via pipe line from the retorting site at Rifle to the refinery site at Chicago was included under raw material transportation. Likewise, the raw material transportation charge for Wyoming crude covers delivery of crude oil via pipe line to a Chicago refinery. In the natural gas and coal cases, product transportation costs to the marketing area are included. The by-product credits include such items as excess fuel gas, petroleum coke, and coal fines.

Charges for depreciation plus interest or return on the investment must be included to ascertain the true competitive relationship between these sources of liquid fuels. Capital charges at 6 percent per year (4 percent depreciation and 2 percent interest on the borrowed capital) represents a return of investment but nonprofit operation over 25 years. At 14 percent per year, the profits after income taxes

TABLE 1
Raw Material Requirements and Products

	Wyoming Crude	Natural Gas	Oil Shale	Indiana Bituminous Coal	Montana Subbituminous Coal
Raw Material Required per Barrel of Liquid Product					
Crude oil, barrels	1.22	....	....	....	....
Natural gas, MCF	....	11.0	....	....	....
Oil shale, tons (30 gal./ton assay)	....	....	1.80	....	....
Coal, tons	....	....	....	0.66	0.80
Liquid Product Distribution, Percent					
Gasoline	82.7	91.4	46.3	91.4	91.4
Gas oil	....	3.5	49.2	3.3	3.3
Residual fuel	17.3	5.1	4.5	5.3	5.3
Total	100.0	100.0	100.0	100.0	100.0
By-Products Produced per Barrel of Liquid Product					
Petroleum coke, barrels (fuel oil equivalent*)	0.11	....	0.09	....	....
Net fuel gas, barrels (fuel oil equivalent*)	....	....	....	0.68	....
Coal fines, tons	....	....	....	0.10	0.15

* Based on fuel oil having 150,000 Btu per gallon net heat of combustion.

TABLE 2
Investment, Dollars Per Barrel Per Calendar Day, of Equivalent Gasoline

	RAW MATERIAL				
	Wyoming Crude	Gulf Coast Natural Gas	Colorado Oil Shale	Indiana Bituminous Coal	Montana Subbituminous Coal
Producing or Mining	$6,800*	$ 300*	$1,100	$1,200	$1,100
Raw Material Transportation	....	400	1,000	100	2,800
Processing	2,700	5,500	8,200	11,200	11,200
Product Transportation	....	....	....	200	800
Operating Investment	$9,500	$6,200	$10,300	$12,700	$15,900
Housing	....	....	1,400	1,200	2,300
Total Investment	$9,500	$6,200	$11,700	$13,900	$18,200

* All exploration costs, dry hole expenses, etc. are charged against crude oil operations without apportionment to natural operations.

TABLE 3
Raw Material Cost (or Price) at Mine or Wellhead

RAW MATERIAL	Unit Price	Direct Costs	Direct Costs Plus 6%/Year on Mining Investment for Depreciation and Interest	Direct Costs Plus 14%/Year on Mining Investment (10 Year Payoff after Income Taxes)
Wyoming Crude	$/Bbl			2.09*
Gulf Coast Natural Gas	¢/MCF			12*
Colorado Oil Shale	$/Ton	0.80	0.88	0.99
Indiana Bituminous Coal	$/Ton	2.54	2.75	3.03
Montana Subbituminous Coal	$/Ton	1.29	1.38	1.53

* Market price assumed.

TABLE 4

Cost of Liquid Fuels Expressed as Cents Per Gallon of Equivalent Gasoline

	Wyoming Crude	Natural Gas	Oil Shale	Indiana Bituminous Coal	Montana Subbituminous Coal
Direct Costs					
Raw material	6.9*	2.8*	4.1	3.4	2.1
Raw material transportation	1.4	0	1.8	0.1	0.8
Processing	2.6	4.3	7.0	7.9	7.9
Product transportation	0	2.1	0	0.1	0.4
Subtotal	11.0	9.0	13.0	13.5	12.3
Less By-Products Credits	1.3	0	0.5	3.2	0.3
Total Direct Cost	9.7	9.0	12.4	10.3	11.9
Direct Costs Plus 6%/Year on Investment for Depreciation and Interest	10.7†	11.9†	16.4	18.3	18.1
Direct Costs Plus 14%/Year on Investment (10 Year Payoff After Income Taxes)	12.2†	15.0†	22.5	22.5	27.6

* Based on market price.

† Do not include charges on investment for raw material production facilities.

TABLE 5

Comparative Estimates of Liquid Fuel Costs

Raw Material	Natural Gas		Oil Shale		Bituminous Coal	
Source	Gulf Coast		Colorado		East of Mississippi River	
Company	Standard-Stanolind	Standard Oil Dev. Co.*	Standard-Stanolind	Standard Oil Dev. Co.*	Standard-Stanolind	Standard Oil Dev. Co.*
Market	Midwest	East Coast	Midwest	California	Midwest	East Coast
Investment/bbl. of total product/CD (including raw material and transportation)	$6,000	$7,100	$9,700	$8,800	$13,300	$9,000
Raw material cost	12¢/mscf	12¢/mscf	$0.99/T	$0.99/T	$3.03/T	$3.03/T
Gasoline Cost (Including 15 percent Charges on Investment)						
Raw material ¢/gallon	3.3	3.0	5.1	4.7	0.5	3.7
Manufacturing and transportation less credits ¢/gallon	12.7	10.0	17.4	14.0	16.0	16.0
Total at market center, ¢/gal.	15.0	13.0	22.5	18.7	22.5	19.7

* Data from paper by Murphree, Gohr, and Barr, A.I.Ch.E. Regional Tulsa Meeting, May 9, 1949.

would pay off the investment in about 10 years. It will be noted that the addition of capital charges to the direct costs for coal and shale places the total cost far above the level for Wyoming crude and natural gas. On the other hand, synthetic products from natural gas can compete today with products from purchased crude if the competitive marketing area is judiciously selected.

The foregoing is all based on the current technological status of synthetic fuels from coal and shale. Present synthesis developments indicate that several phases of the processes are subject to much improvement. Although it is difficult to evaluate quantitatively the effect of possible improvements on the cost of synthetic fuels, such a computation is desirable to indicate the probable benefits to be derived from future research work. Several process improvements in coal synthesis, such as use of lower H_2:CO ratio and improved methods of coal gasification, are believed to have an even chance of accomplishment. If all of these improvements can be realized, the cost of equivalent gasoline from Indiana bituminous coal could be reduced from 22.5 to 17.0 cents per gallon. These costs should be compared with 12.2 cents per gallon for equivalent gasoline from Wyoming crude. Reductions are also possible in the costs of manufacturing liquid fuels from oil shale.

Numerous other estimates of the costs of liquid fuels from sources other than petroleum have been published. Bureau of Mines spokesman[7] have quoted investments of $3100 per daily barrel of capacity from oil shale, $5300 per daily barrel from natural gas, and $9600 per daily barrel from coal (including mining). Direct comparison of most previously published estimates with those obtained in this study is impossible because the basis and scope of these estimates were not given or were not detailed. However, results of a similar study by Standard Oil Development Company were given[8] in sufficient detail to permit a comparison as indicated in Table 5. These data have been adjusted to a common raw material cost, but charges on investment were unchanged because Standard Oil Development Company used 15 percent while, in this study, 1 percent ad valorem tax had been included in manufacturing costs prior to addition of 14 percent charges on investment.

For the natural gas cases, the differences in manufacturing and transportation costs may be due to a combination of the transportation charges to different markets and the crediting of by-products. For the oil shale cases, a similar discrepancy may be due, in part, to the same factors.

The bituminous coal estimates show a marked difference in raw material costs. The Stanolind case has a low liquid product yield. However, it consequently produces a large quantity of by-product gas which, as a credit, reduces the manufacturing costs. Some portion of the 2.8 cents per gallon difference is attributable to the inefficiency of the Stanolind case introduced by conversion of generator gas to a higher H_2:CO ratio.

In general, the agreement between these estimates is considered to be quite good. The fact that Stanolind estimates are consistently high reflects the basic conservative premise that the designs would incorporate proved processes with a minimum reliance on untested technological improvements. As was previously mentioned, eventual validation of some of these probabilities could reduce the estimated costs of synthetic gasoline from coal from 22.5 cents per gallon to 17 cents per gallon.

In summary, the production of liquid fuels from oil shale or coal is in an immature state of technical development. It can be expected that continued research will result in process improvements which will effect significant reductions in the investments, operating costs, and raw material requirements involved in synthetic liquid fuels manufacture.

From the standpoint of economics, this study shows that, at present, liquid fuels from oil shale and coal cannot compete with those derived from crude petroleum. Natural gas as a raw material may or may not be competitive, depending on the relative locations of raw material supply and product markets.

Based only on present technological status and estimated products costs, a choice between coal and oil shale as alternate raw materials for liquid fuel production cannot be made. Future research on these processes, however, should indicate which process is superior.

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[7] W. C. Schroeder, "Synthetic Fuels Plants," presented before Petroleum-Mechanical Engineering Conference, ASME, Amarillo, Texas, October 6, 1948.

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THE USE OF cylindrical furnaces for the petroleum industry has steadily increased since the advent of the original cylindrical furnace invented by Luis de Florez for refinery use some 20 years ago. This type of furnace has not been universally adopted, the author believes, primarily because of a lack of understanding of its capabilities. The purpose of this discussion, which was given before the semi-annual meeting, San Francisco, June, 1949, of The American Society of Mechanical Engineers, is to describe and comment upon de Florez, Iso-Flow and other types of cylindrical furnaces.

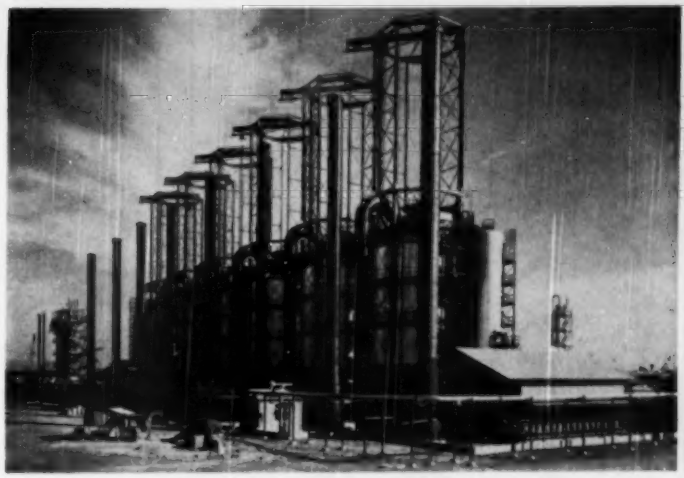


Figure 2. Arrangement of Six Furnaces

Cylindrical Furnaces for the Petroleum Industry

O. F. CAMPBELL
Sinclair Refining Company, East Chicago, Ind.

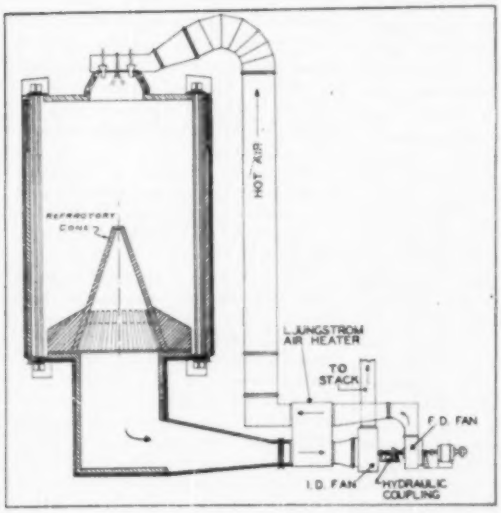


Figure 1. Down-Draft de Florez Furnace Equipped with Air Heaters.

THE cylindrical furnace has been successfully used for many duties such as crude topping, heating reduced crude for vacuum distillation to produce lubricating oils and asphalts, light and heavy gas oil cracking, evaporating and superheating oil vapors for the Houdry and Thermafor catalytic cracking processes, heating up lube oils and solvents, heating up fat absorption oil for casing head production, high and low temperature steam superheating, heating asphalts for loading purposes, domestic heating, and many other uses. The future offers still greater development and use because of its simplicity and flexibility it can be built for substantially any duty, capacity, or efficiency. Its inherent design automatically provides more uniform heat distribution and absorption, low maintenance, low radiation losses, ease of cleaning, adaptability to heat recovery equipment, less fire hazards, low space requirements, etc.

de Florez Furnaces

The original design of the de Florez furnace was a down-fired furnace using cold forced air, a bottom convection section and a natural draft stack. Subsequent installations had many variations. Some were fired from the bottom with a convection section on top using neither forced nor induced draft. Some were bottom-fired using a convection section and air heater on top and a forced-draft fan. The up-fired units normally do not have induced draft. The air heaters located on top of the

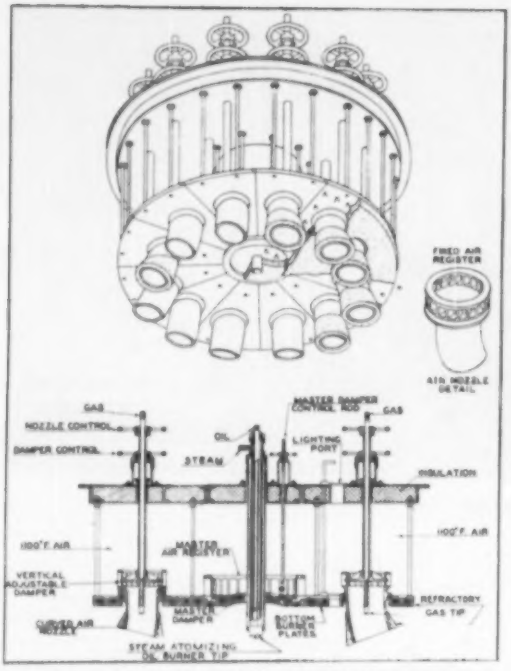


Figure 3. Special Burner Used with Down Draft de Florez Furnaces and Air Heaters.

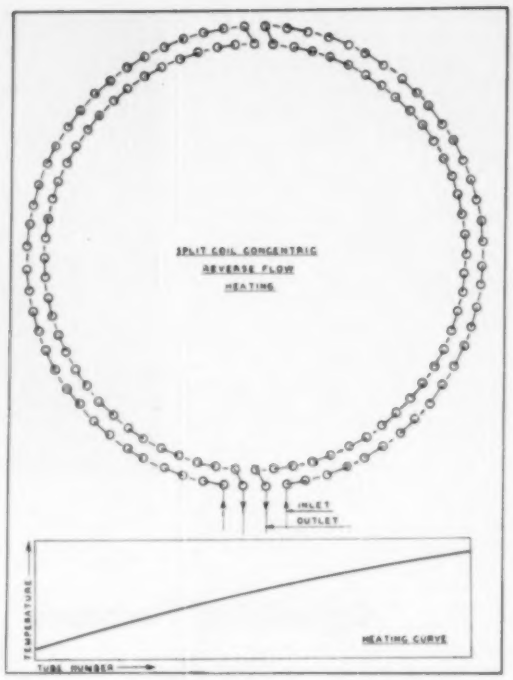


Figure 4

furnace were of the tubular or plate type to keep the draft drop to a minimum to avoid the use of a taller stack. The furnace and air heater being vertical, produced a chimney effect and actually served as part of the stack.

The most successful design of the de Florez furnace which has been adopted as a standard by Sinclair Refining Company consists of: a) top supported all radiant oil heating tubes, b) down firing with a specially designed directional flame control oil and gas fired burner, c) a vertical refractory cone resting on the bottom of the furnace for better heat distribution, d) a high temperature Ljungstrom air heater, e) forced and induced draft fans motor driven, f) and a short self supporting steel stack. This general design is shown by Figure 1. An arrangement of six of the furnaces is shown by Figure 2.

The details of the directional flame control burner is shown by Figure 3. This burner handles refinery gas, natural gas, or heavy fuel oil. The fuel oil burner is of the steam atomizing type. This directional flame control burner can provide the desired flame shape. The flame can be made long and narrow or short and bushy as desired. The flame can be shifted from one side of the furnace to the other to give the desired heating curve. Each 7-inch i.d. air nozzle can supply enough air to burn between 10 and 15 million Btu. per hour.

The de Florez furnace is very adaptable to substantially any design of tube arrangement to give the required oil heating curve. For thermal cracking it is desirous to heat the oil to be cracked up to a predetermined temperature as rapidly as possible and then to maintain that temperature to provide time for cracking or "soaking time." For crude topping and for heating up gas oil for catalytic cracking it is advantageous to have very little or no thermal cracking and no "soaking time." In practically all oil heating problems by direct firing the oil is forced through the tubes in series flow although there may be several heating coils in the same furnace. To reduce pressure drop through the oil heating coils it is sometimes desirable to parallel the oil tubes at points of vaporization. This is normally done on vacuum distillation units or where it is necessary to vaporize the oil and then superheat the vapors. Where only superheating of vapors is required there may be several parallel flows.

To simply illustrate the flexibility of design of the cylindrical furnace no more than two heating coils in any one furnace has been selected. In the majority of cases the two coil furnace is the more practical from design and operating standpoints. Figures 4 through 9 illustrate some of the tube arrangements used and the effect of these tube arrangements on the shape of the oil heating curve. From the various tube arrangements and oil heating curves it can readily be seen that almost any kind of a heating curve can be obtained. If a furnace is designed for thermal cracking it is only necessary to reverse the oil flow to provide an oil heating furnace without cracking.

Figure 4 shows a split coil arrangement with the oil entering the back row of tubes going half the distance around the furnace and then returning through the inside row of tubes. All return bends are the same size to simplify design. This furnace was designed for heating with no "soaking time" and the slope of the heating curve shows no "soaking time." The split coil was used to reduce pressure drop.

Figure 5 shows another type of split-coil, staggered-flow arrangement for

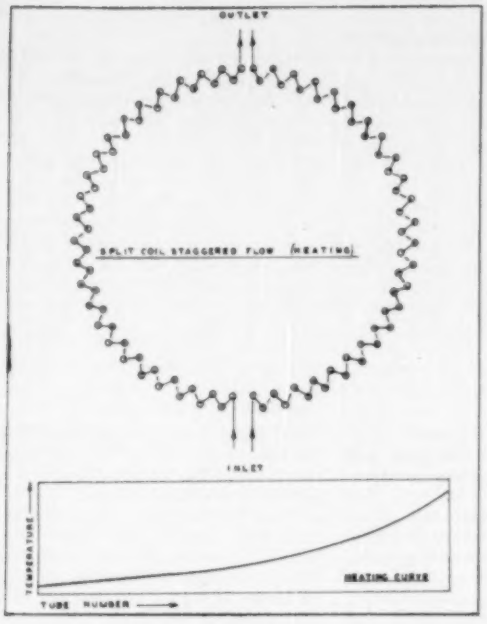


Figure 5

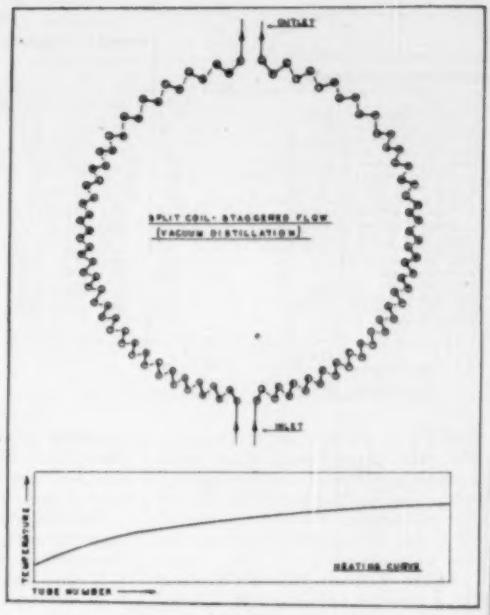


Figure 6

oil heating duty only. The oil heating curve of this furnace was desirable because reduced crude of high salt content was being heated and the salt deposited near the inlet tubes. The flame control burner was used to direct the flame toward the outlet tubes. Tube shields were also used to keep too much heat from being absorbed by the first four inlet tubes where the salt deposited.

Figure 6 shows a split-coil staggered

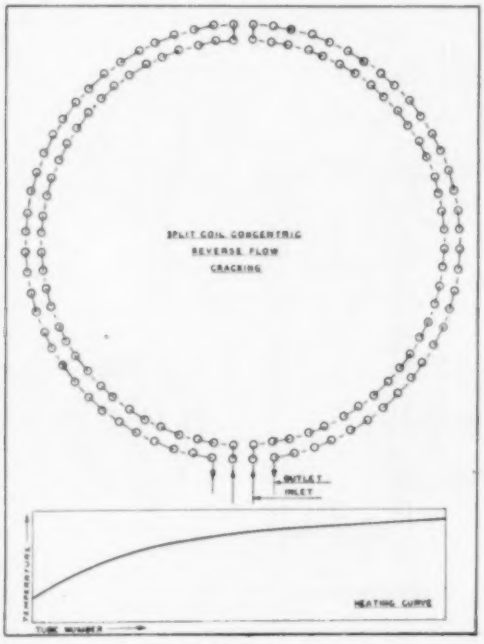


Figure 7

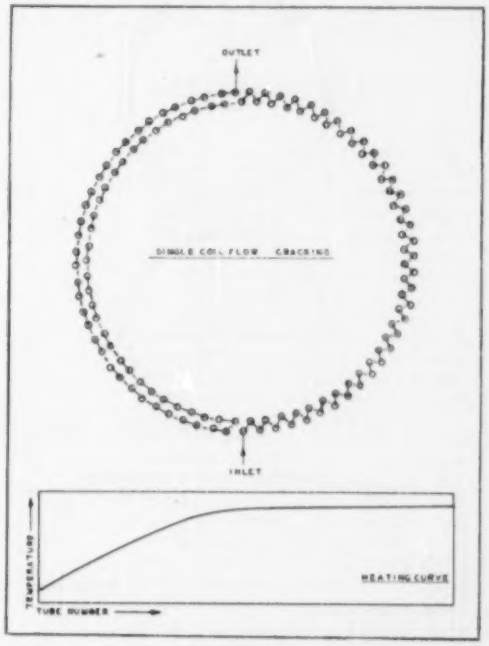


Figure 8

TABLE 1

Summary of Operating Data on Duflorez Heaters

COMBUSTION SURVEY DATA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fuel Used	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas	R. Gas
Percent CO_2 Entering Air Heater	10.4	10.4	10.7	13.0	10.2	11.4	11.4	11.8	11.0	10.8	11.8	10.4	11.8	11.3	12.0	11.1
Percent O_2 Entering Air Heater	4.6	4.8	3.2	2.0	4.1	3.1	3.2	1.8	3.4	3.8	2.0	3.5	1.5	2.8	.9	2.3
Percent CO_2 Leaving Air Heater	9.0	9.0	9.1	10.0	8.8	9.6	9.2	9.8	8.7	9.0	10.0	9.0	10.3	10.1	10.8	9.9
Percent O_2 Leaving Air Heater	6.9	6.8	5.9	5.3	6.4	5.8	5.9	5.8	7.4	6.9	5.3	5.7	4.0	4.4	2.6	4.2
Flue-Gas Temperature (°F.) into Air Heater	1290	1117	1010	1210	980	1190	980	980	1025	980	1035	910	888	970	1205	1170
Flue-Gas Temperature (°F.) out of Air Heater	490	521	470	440	495	465	385	355	495	390	380	360	400	435	493	510
Air Temperature (°F.) into Air Heater	22	60	60	33	60	33	26	62	56	10	22	101	100	100	99	63
Air Temperature (°F.) out of Air Heater	810	790	730	830	705	835	735	730	855	815	850	735	755	812	975	980
Air Pressure (" H_2O) into Air Heater	4.9	5.0	4.20	4.75	3.8	7.75	4.4	5.0	6.23	5.5	6.0	5.2	4.9	6.7	7.6	9.7
Air Pressure (" H_2O) out of Air Heater	3.5	3.0	2.6	3.5	2.4	3.5	3.0	4.0	4.73	4.25	3.5	3.1	3.0	4.1	4.7	6.4
Fule-Gas Draft (" H_2O) into Air Heater	.85	.80	.75	.75	.65	.80	.85	.90	1.10	.80	.95	.80	.80	1.0	1.0	1.40
Fule-Gas Draft (" H_2O) out of Air Heater	1.60	2.20	2.5	1.88	2.3	2.50	2.2	2.0	2.2	2.4	2.9	.34	3.8	4.5	5.0	6.60
Percent Air Heater Leakage[1]	18.6	18.3	18.0	20.0	18.0	17.7	23.9	20.0	20.4	20.0	18.0	13.0	13.0	10.0	9.60	10.0
Percent Stack Loss	19.2	19.5	19.5	17.5	19.9	18.0	18.1	18.3	17.8	18.5	18.8	16.1	16.4	16.6	17.7	19.5
Percent Efficiency[2]	78.8	78.5	78.3	77.5	78.1	77.0	78.9	79.5	77.2	78.1	79.3	78.9	78.6	78.4	77.3	75.2
Million Btu. Liberated in Furnace	49.5	52.1	56.3	84.0	59.4	70.0	71.68	73.6	94.7	89.96	91.66	93.3	102.0	117.0	127.0	137.9
Million Btu. Absorbed by Oil Tubes	37.52	39.33	42.34	44.50	44.61	53.9	56.55	58.51	65.39	70.23	72.50	73.61	80.17	91.73	98.17	103.7
Length of Elements	27"	27"	27"	27"	27"	27"	36"	48"	48"	48"	48"	48"	48"	48"	48"	48"

[1] Percent leakage = $\frac{(\%\ CO_2\ \text{in}) - (\%\ CO_2\ \text{out})}{\%\ CO_2\ \text{out}} \times 100$.

[2] Percent efficiency = [$100\% - (\text{Stack loss} + 5\%\ \text{radiation\ loss})$]

flow for a vacuum distillation unit. The tube arrangement is the same general layout as shown by Figure 5 except that the last two tubes in each coil are parallel flow. Any number of tubes can be paralleled or tube size may be increased.

Figure 7 shows tube arrangement for a thermal cracking still. The oil flows through a split coil concentric reverse flow with the oil passing through the inside row first to be heated up to cracking temperature and then through the second and back row for "soaking." The shape of the heating curve indicates satisfactory conditions for cracking. The split coil provides lower pressure drop and satisfactory soaking time.

Figure 8 shows a single coil of the staggered concentric reverse flow tube layout for a thermal cracking still. This tube arrangement provides very good thermal cracking conditions but has a rather high pressure drop and represents somewhat of an extreme soaking condition not necessarily required.

Figure 9 shows a thermal cracking still equipped with two furnaces. The first furnace is a split staggered flow for heating the oil up to a cracking temperature. The second furnace is a split coil concentric reverse flow for soaking. The heating curve of this arrangement can be held almost any shape to provide optimum cracking. The two furnace hook-up has the disadvantage of higher first cost per barrel of gasoline produced as compared with two furnaces each designed as shown by Figure 7.

With proper understanding of tube arrangement, flame control for heat distribution, refractory cone for better

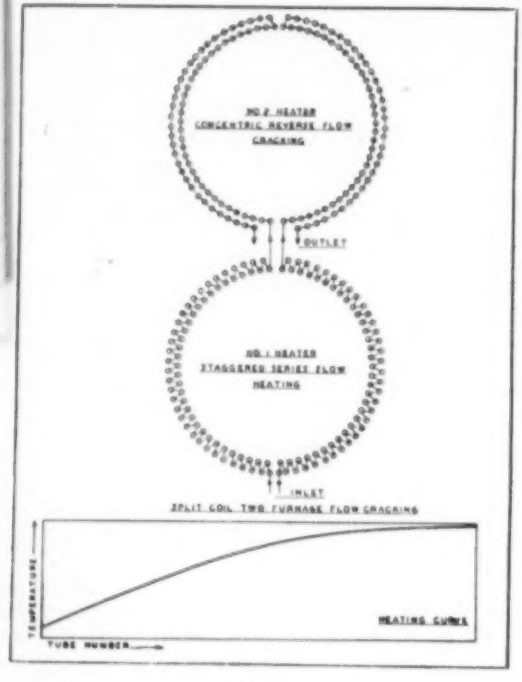


Figure 9

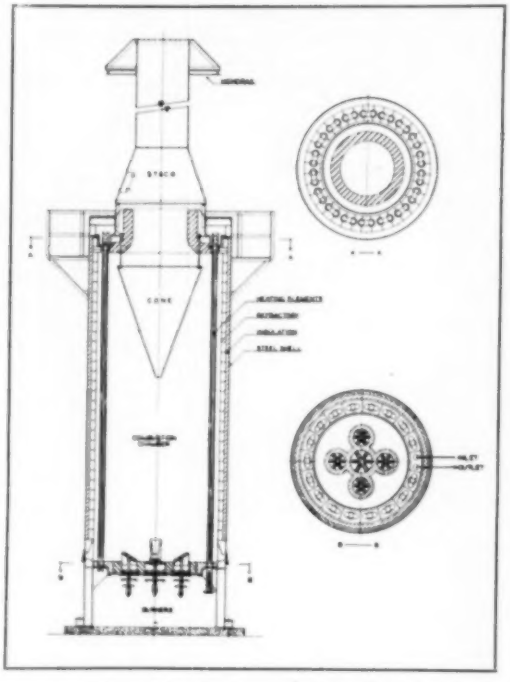


Figure 10. Iso-Flow Furnace. Radiant Type.

heat distribution, and highly preheated air the de Florez furnace can be designed for maximum heat absorption and maximum efficiency regardless of inlet or outlet oil temperatures, for any kind of service required. Maintenance is low because the oil tubes protect the refractory walls. Some of these de Florez furnaces have been in use about 20 years without any maintenance to refractory walls or top arch. Burner throats are the major source of repairs and some of the throats are over 10 years old without replacing. Some thermal cracking furnaces have operated as high as 120,000 hours without tube replacement attributed largely to proper heat distribution and tube arrangement.

The de Florez furnace has some desirable features worthy of note. Cast iron tube sheets are used to support the tubes and no expensive alloys are used for tube supports. With suspended tubes any tube warpage is of no consequence. When burning fuel oil with high ash content the accumulation of ash does not plug off any flue gas passage or appear to interfere with heat transfer. As the ash builds up on the tube the furnace temperature increases enough to obtain the desired heat transfer without materially increasing the flue gas temperatures entering the air heater. All tubes may be readily observed. Thermocouples may be placed at will and hot tubes can be seen with ease.

The use of the Ljungstrom type air heater makes it uneconomical to install a convection section as the air heater can do a better job cheaper. The air heater can be designed to give an efficiency equivalent to boiler practice if desired. The use of highly preheated air increases the rate of heat absorption by radiation and will decrease the number of oil tubes required for a definite quantity of heat to be absorbed. In some cases where expensive alloy tubes are required for sour crude operations the reduction in cost of oil tubes will offset the cost of an air heater, fans, and their drivers.

The fuel prices of the past few years have compelled the installation of air heaters or other heat recovery equipment to reduce fuel costs in order to survive in this highly competitive field. Table 1 gives some standard every day operating data for de Florez furnaces as outlined above.

Iso-Flow Furnaces

There are, of course, other types of cylindrical furnaces than the de Florez that must be considered. The Iso-Flow furnace of Petro-Chem Development Company has some ingenious design features. It is the writer's opinion that this furnace has its greatest application where the mean oil temperature is low. There are no reasons, however, why the furnace cannot be designed with an air heater to give high efficiency and in many instances this is done.

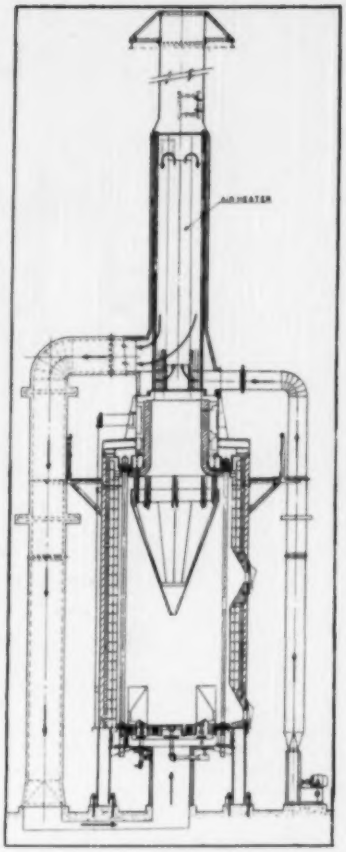


Figure 12. Iso-Flow Furnace, Radiant Type with Air Heater.

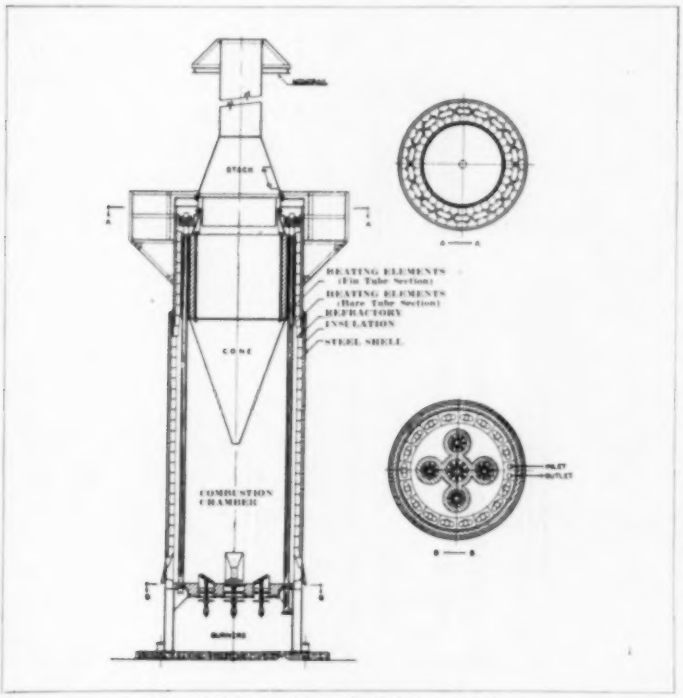


Figure 11. Iso-Flow Furnace, Radiant-Convection Type.

The furnace is popular because it is adaptable for small heat duties, is cheap to build, requires small ground space, has high efficiency for low temperature stocks without the use of an air heater or fans. It fills the needs of the smaller furnace field efficiently and economically. The writer is only familiar and experienced with Iso-Flow furnaces up to 50 million Btu. absorption per hour and for relatively low average temperature of stocks to be heated, and shall limit illustrations and comments accordingly.

The original design of the furnace consisted of a vertical cylindrical shell of light sheet steel, insulated on the inside with insulating refractory or

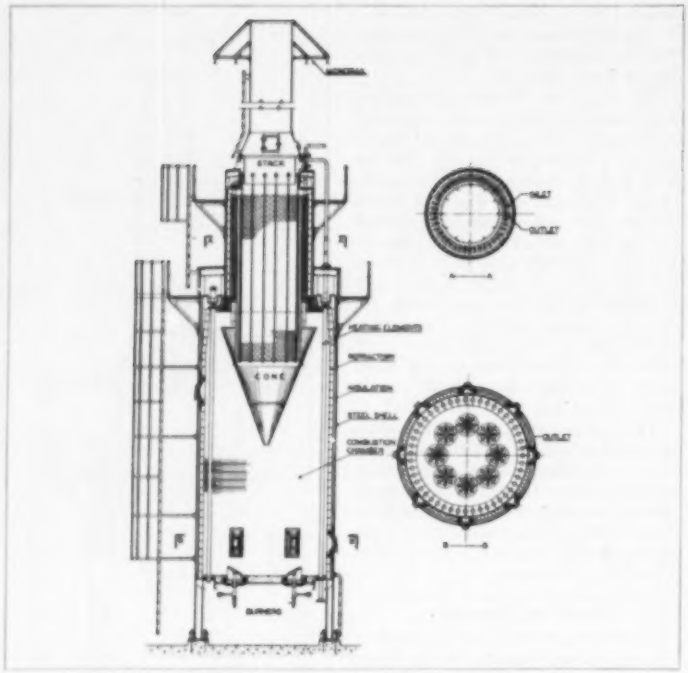


Figure 13. Iso-Flow Furnace with Separate Convection Section.

firebrick. Inside this insulated cylinder bottom supported vertical tubes were erected adjacent to the wall, burners were placed in a refractory well located at the bottom of the furnace, and the flue gases escaped through a stack placed on top of the furnace. There was suspended in the top of the furnace an alloy or refractory cone to radiate heat to the upper part of the tubes and to deflect the flue gases around the tubes in the upper part of the furnace. There have been many improvements and innovations over the original design.

Figure 10 illustrates the radiant type Iso-Flow furnace. The original firing well at bottom of furnace has been eliminated and this furnace is equipped with five burners in the bottom of the furnace. The four outside burners are so designed as to give direction to the fire and distribution of heat to the tubes. The tubes are supported from the bottom and are set in a single row. The bottom of the stack is equipped with a draft hood somewhat similar to a draft hood on a domestic gas furnace. The stack is equipped with a circular mono rail for tube removal and cleaning purposes. The upper throat of the furnace is made of refractory. No supporting structural steel is employed thereby making a less costly installation. The efficiency of this type of furnace is dependent upon the excess air in the furnace, average temperature of stock inside the tubes and the heat absorption rate. This type of furnace is usually used where low cost of installation is required and low priced fuel is available.

Figure 11 illustrates the radiant-convection type Iso-Flow furnace. The design of the radiant-convection type is substantially the same as the radiant type except that the radiant cone is suspended from a hollow cylinder inserted at the top of the furnace. The tubes between the two concentric hollow cylinders are equipped with longitudinal fins and constitutes the convection section. The radiant convection types are usually used where fuel economy is desirable and low average oil temperatures are encountered. The fins or extended surface increases the heat absorption by the tubes in the convection section to substantially that of the radiant section and at the same time increases the efficiency. With an average temperature of approximately 450° F. of oil in the tubes, the efficiency of the radiant-convection type

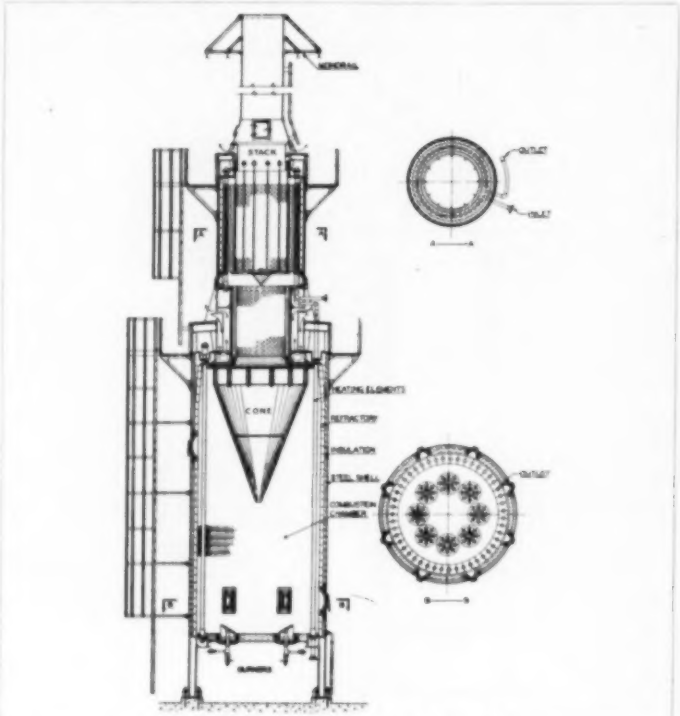


Figure 14. Iso-Flow Furnace with Separate Convection Section.

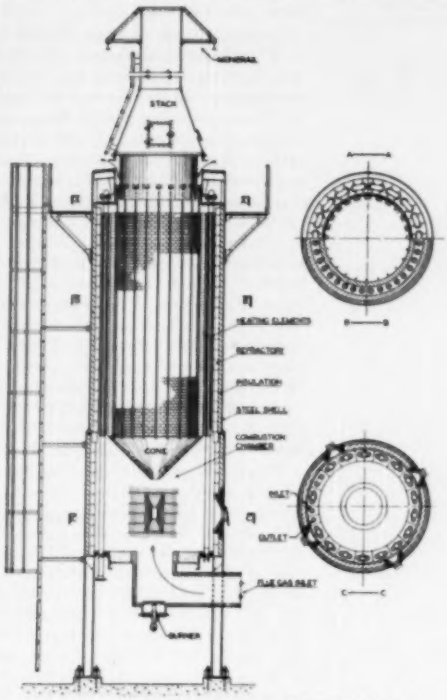


Figure 15. Iso-Flow Economizer. Auxiliary Fired Type.

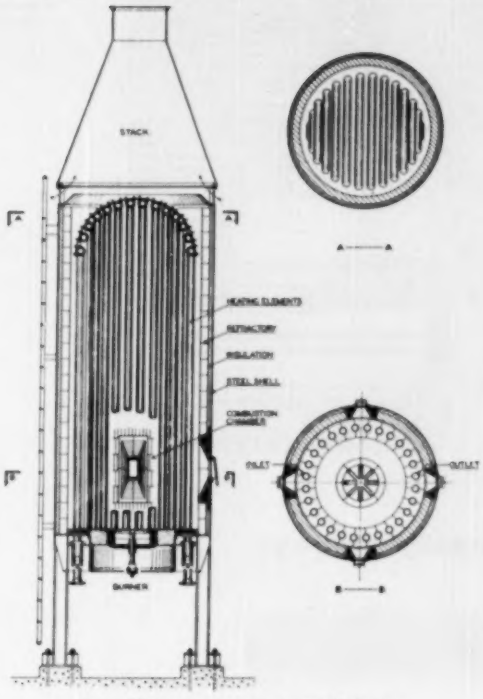


Figure 17. Iso-Flow Furnace. Bent Tube Type.

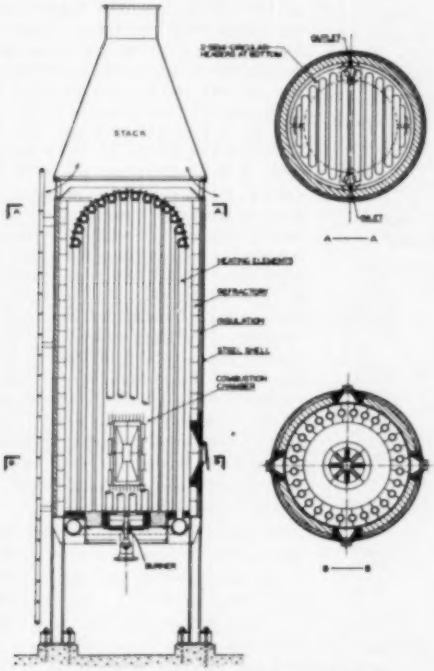


Figure 16. Iso-Flow Furnace. Bent Tube Superheater.

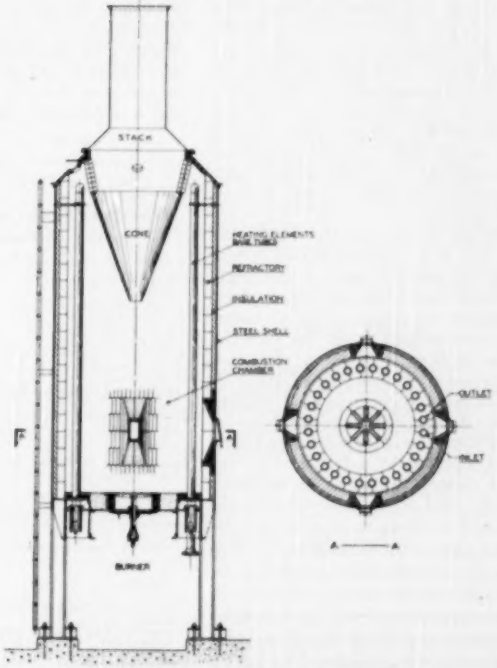


Figure 18. Iso-Flow Furnace. Radiant Type (Inverted U).

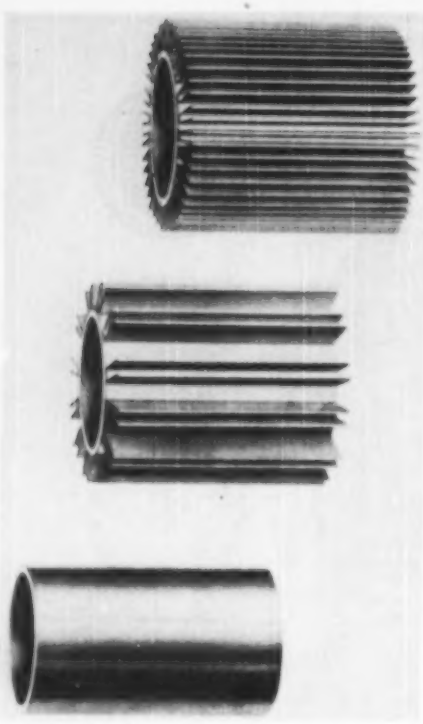


Figure 19. Illustration of Extended Surface for Convection Section.

for a heat absorption rate based on tube surface only of 8000 to 10,000 Btu. per square foot per hour is approximately 70-72 percent based on the gross heating value of the fuel.

Figure 12 illustrates an Iso-Flow furnace of the radiant type equipped with an air heater to provide greater economy and to obtain greater heat absorption rate per square foot of tube surface.

The air heater is of the tubular design and is inserted in the stack and forms an integral part of the stack. The stack forms the outer shell of the air heater. Inasmuch as the air heater is in the vertical stack the chimney action of the flue gases in the stack overcomes the major part of the draft loss of the flue gases passing through the air heater and as a result no induced draft fan is required. The forced air is supplied by a forced draft fan which delivers the air to the air heater and the cold air first passes over the bottom tube sheet to keep the bottom tube sheet as cold as possible and then through a circular duct located in the center of the air heater to the top of the air heater where the air then flows counter current to the flue gases passing through the air heater. The hot air leaving the air heater flows downward through an insulated duct to the windbox located at bottom of furnace. The efficiency of this type of furnace can be as desired and will depend upon the price of fuel. If fuel prices are high a large heater can be used and if fuel prices are low a smaller air heater may be used.

TABLE 2

Petro-Chem Furnace Design Data for Heating Oil-Phenol Mixture[1]

Number of Tubes	44
Size of Tubes	5" x 4"
Radiant Surface	1879 sq. ft.
Convection Surface	2487 sq. ft.
Total Surface	4066 sq. ft.
Tube Circle Diameter	10' 6"
Inside Furnace Diameter	11' 9"
Height of Furnace	38'-3½"
Height of Stack	31'-0"
Total Height of Furnace and Stack	68'-3½"
Combustion Volume	2524 cu. ft.
Number of Burners	9
Type of Burners	John Zink (Directional-Spider Premix)
Length of Convection Section	7'
Length of Radiant Section	27'-4½"
Btu. released per hour (normal)	21,200,000
Btu. absorbed per sq. ft. Radiant Section	8,900
Btu. absorbed per sq. ft. Total Surface	4,070
Flue gas temperature convection inlet	1000 °F.
Flue gas temperature convection outlet	640 °F.
Excess Air	40%
Temperature Oil-Phenol Mixture into Furnace	420 °F.
Temperature Oil-Phenol Mixture out of Furnace	560 °F.

[1] Sinclair Refining Company, Houston.

Figures 13 and 14 show designs of Iso-Flow furnaces equipped with separate convection surfaces but without air heaters. Air heaters can be added to furnaces of this design if greater efficiency is desired. It is the writer's opinion that the more economical arrangement would be a radiant-convection furnace for high average oil temperatures as shown by Figure 11 supplemented by air heater instead of arrangement of surfaces as shown by Figures 13 and 14. Figure 13 illustrates a design of a separate convection section where services are such that it is unnecessary to internally clean the convection section. Figure 14 illustrates a design of a separate convection section where services are such that the convection section must be cleaned internally.

Figure 15 shows an Iso-Flow economizer of the auxiliary fired type which may have many possibilities. This unique design allows control of the temperature of the products heated and at the same time effects a fuel saving by recovering heat from the hot flue gases of existing inefficient units. For example, a box type cracking still having a radiant furnace and a down draft convection section may be already installed. The charging stock to this furnace may be as high as 700° F. and a stack temperature may be as high as 900 to 1000° F. The excess air in the flue gases from this furnace may be as high as 75 percent to 100 percent and there is usually enough excess oxygen in the flue gases to supply oxygen for the auxiliary fire of the Iso-Flow economizer and no added air would be required. If more selective cracking, or another heating furnace is desired, and there usually is in any refinery, the auxiliary fired economizer may be justifiable. In fact an air heater on top of the separately fired economizer could supply hot air to the original cracking furnace and as a result greater capacity and efficiency could be effected. This separately fired economizer may be a steam boiler as will be described later in this paper. There may be many applications to this separately fired economizer and each refinery's problems will be different.

Figure 16 illustrates an Iso-Flow bent tube parallel flow superheater. This type of superheater is usually used for superheating steam where fuel economy is not essential, total heat absorbed is quite low, and where first low cost is important. There are a large number of furnaces of this type and they are used to superheat

steam from field boilers which are not designed with superheaters.

Figures 17 and 18 illustrate inverted bent tube series and parallel flow radiant type Iso-Flow furnaces of low capacity where low first cost is paramount and efficiency unimportant.

Figure 19 illustrates the design of the extended convection surface. The longitudinal fins are welded to the tubes by automatic welding equipment and as a result this extended surface is not too expensive. The design of this extended surface is such that the heat absorption per square foot of tube surface is approximately the same in both the radiant and convection sections. Where the average temperature of the stock in the tubes does not exceed approximately 550° F. and with the proper design of radiant and convection sections it is usually uneconomical to install an air heater or other heat recovery equipment.

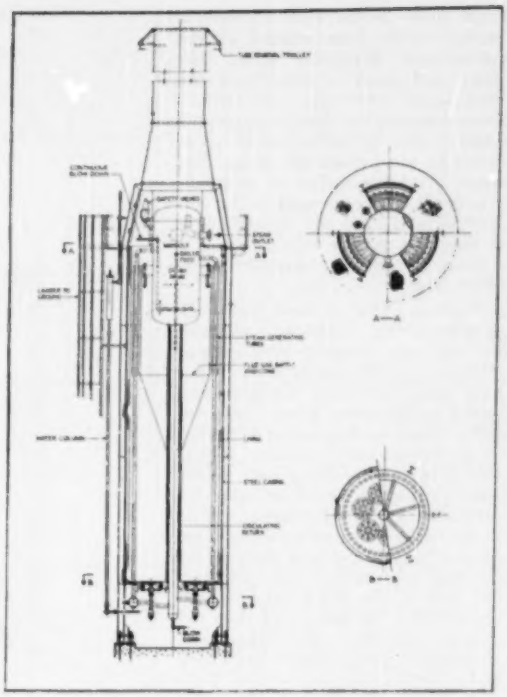


Figure 20. Iso-Flow Furnace. Steam Generator.

Operating and Design Data

In verification of the performance of an Iso-Flow radiant-convection type furnace three tests were made on a furnace heating a mixture of Oil-Phenol at Sinclair Refining Company's plant at Houston. Table 2 shows some pertinent design data. Table 3 shows a tabulation of the test data. It is apparent from the test data that the unit did not operate under the same conditions as designed which is the usual practice for oil refinery equipment. The flue gas temperatures were higher leaving the convection section than design but the excess air was less. The same may be said for flue gas temperatures for the convection section inlet. Some interesting items of the tests revealed that the furnace could be operated at 35 percent above normal design with an efficiency of 73 percent based on the gross heating value of the fuel, the radiation loss was low, the lowest excess air during normal operation that could be obtained was approximately 15 percent in the furnace and 22 percent leaving convection section indicating a better burner desirable, furnace temperatures were higher than expected, control of outlet oil-phenol mixture temperatures easily accomplished, and very uniform with split coil flow, and no operating difficulties.

TABLE 3

Test Data on Petro-Chem Furnace[1] for Heating Oil-Phenol Mixture

	Test No. 1	Test No. 2	Test No. 3
Charge to Furnace B/D	4,950	7,200	6,660
Temperature Charge in °F.	432	432	435
Temperature Charge out °F.	570	586	565
Million Btu. Released/Hr.	18.6	28.9	27.2
Million Btu. Absorbed per Hour, Convection Section	1.7	4.1	3.5
Million Btu. Absorbed per Hour, Radiant Section	12.2	17.0	16.4
Total Btu. Absorbed/Hour	13.9	21.1	19.9
Percent Efficiency Higher Heating Value Basis	74.6	73.1	73.2
Percent Stack Loss Higher Heating Value Basis	23.3	25.9	25.6
Percent Radiation Loss Higher Heating Value Basis (actually determined)	2.1	1.0	1.2
Btu. Absorbed/Sq. Ft. of Convection Surface	683	1,640	1,407
Btu. Absorbed/Sq. Ft. of Radiant Surface	7,720	10,766	10,388
Btu. Absorbed/Sq. Ft. of Total Surface	3,420	5,189	4,894
Btu. Absorbed/Sq. Ft. Tube Surface	6,881	10,446	9,851
Btu. Released per Cu. Ft. Furnace Volume	7,370	11,450	10,777
Percent Heat Absorbed Convection Section	12.2	19.5	17.6
Percent Heat Absorbed Radiant Section	87.8	80.5	82.4
Temperatures, °F.:			
Furnace—9' Below Convection Section	1,196	1,325	1,302
Entering Convection Section (2' Below Convection Section)	1,049	1,312	1,355
Leaving Convection Section	699	720	793
Hood	632	644	616
Ambient Air	65	62	60
Drafts "H_2O:			
Hood	—.24	—.23	—.23
Stack	—.16	—.16	—.17
Furnace	—.48	—.50	—.55
Flue Gas Analyses:			
Percent CO_2 Entering Convection Section	10.8	10.5	11.5
Percent O_2 Entering Convection Section	3.8	4.3	2.6
Percent CO_2 Leaving Convection Section	10.8	9.9	10.8
Percent O_2 Leaving Convection Section	3.8	5.2	3.5
Kind of Fuel	Refinery Gas	Refinery Gas	Refinery Gas
Btu./Cubic Ft. Fuel Gas	1,994	1,863	1,575

[1] Sinclair Refining Company, Houston.

Boiler Design

The application of the cylindrical furnace to a steam boiler is another variation of the Iso-Flow design. One cylindrical furnace boiler has been in operation for several years and consists of a horizontal drum located above the furnace into which the furnace tubes deliver the water-steam mixture and is quite similar to a conventional boiler design. The furnace tubes are supplied with water by outside downcomers from the boiler drum. It is understood that this boiler operates satisfactorily well above design capacity.

Figure 20 illustrates a new and

novel boiler design which includes a vertical steam drum instead of the conventional horizontal drum. The steam and water mixture from the fired boiler tubes enter the vertical drum horizontally where it is given a rotary motion by baffling for the separation of water from the steam. The steam liberating surface is therefore a hollow cylinder of water in the vertical plane around the circumference of the drum and the boiler drum is a vertical centrifugal separator which offers many possibilities.

There are four of these boilers in operation. The boilers are designed for 400 psig. working pressure and 30,000 to 50,000 pounds of steam per hour each. The boiler is bottom supported by the boiler tubes. The circulating return or downcomer is located in the furnace and is insulated to prevent it from becoming a riser. Boiler water circulation should be more uniform than in the conventional boiler as each boiler tube passes through the furnace proper and then through the fin type convection section. The bottom end of the steam drum is surrounded by flue gases and does not require insulation. The boiler is a single pass boiler, has low draft drop and in fact the furnace is a part of the stack.

This type of boiler is not readily adapted for a superheater and where superheat is required a separately fired superheater is used. The Iso-Flow boiler could readily be installed as an economizer as illustrated in Figure 15. The fuel for the immediate future will probably be oil and or gas but this type of boiler could be readily adapted to solid fuel firing. The Iso-Flow boiler may have rather extensive applications where fuel oil and gas are the prevailing fuels and where outdoor installations are desired.

Helical Coil Furnaces

The Helical coil furnace has many applications from a domestic hot water heater to heating up oil stocks where the heat absorption may be as high as 20 million Btu. per hour. Furnaces of this type are used where there is little or no likelihood of coking up or of being plugged. One application for the Helical coil is heating up asphalt for tank car loading when it is necessary to load hot asphalt into insulated cars so that asphalt may be taken directly from the cars at point of delivery without heating. Hot asphalt may be transported as much as 1000 miles without cooling off to the extent that it will have to be heated for unloading at point of destination. Another application of the Helical coil is the heating up of a mixture of propane and asphalt at a propane deasphalting plant. Small steam superheating Helical coil furnaces are frequently used.

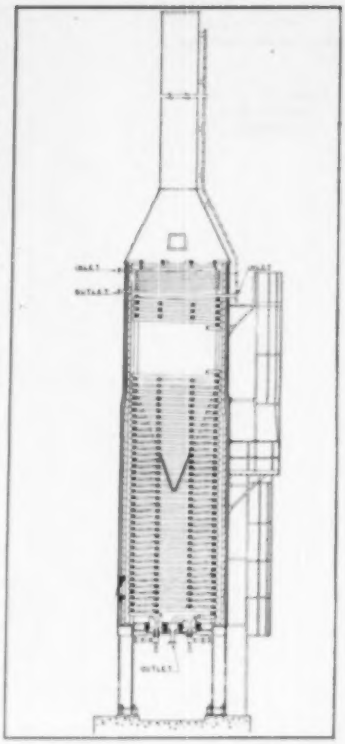


Figure 21. Iso-Flow Furnace, Radiant-Convection Type, Two Flow Helical Coil.

The Helical coil furnace is normally only used where part time operations are required, where fuel is cheap, and low first cost is desired. It is needless to say that the Helical coil furnace is cheap to build. For refinery use the coils are held apart by welded spacer bars about two inches long uniformly spaced for supporting the tubes one upon the other. Figure 21 illustrates the design and application of a Helical coil in a furnace.

The Helical coil has the disadvantages of inefficiency and probability of plugging up. On the other hand it has the advantages of cheapness and ease and speed of removal and replacement of heating surface. The draft hood is easily removed and then the entire coil can be replaced as a unit.

Miscellaneous Cylindrical Furnaces

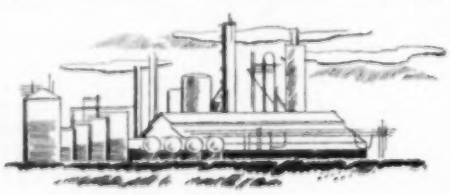
Several cylindrical furnaces have been successfully used to burn obnoxious gases and to evaporate foul waters. Horizontally fired gas burners are installed at the base of the cylinder and the foul water is sprayed into the top of the furnace. The same arrangement is used to completely burn up obnoxious gases. In one instance a vertical storage tank was converted into a flambeau by lining the tank with refractory and locating the burners around the base of the tank.

Summary

The cylindrical furnace has a definite place in the oil industry. There appears to be no heating task in an oil refinery where a cylindrical furnace cannot be readily adapted. Its fundamental concept provides for more uniform heat distribution and absorption. In an all radiant cylindrical furnace the coldest tube absorbs more heat than the hottest tube and the furnace adjusts itself with each tube absorbing its aliquot portion of heat in proportion to the fourth power of the absolute temperature difference between the flame and the tube. It can be designed for substantially any duty and efficiency. Each type of cylindrical furnace described here has its place. It is the writer's opinion that the cylindrical furnace is the best when designed with proper understanding and this paper is dedicated to this proper understanding.

ACKNOWLEDGMENTS

The writer acknowledges assistance from Petro-Chem Development Company which furnished Iso-Flow furnace designs, Richfield Oil Company for furnishing photographs of de Florez furnaces, Coen Burner Company for furnishing the original directional flame control burner design, and W. H. Decker, Sinclair Refining Company.



A DISCUSSION of fundamental operating requirements and aims in the liquid phase of hydrogenation is contained in Part II and requirements on coal solvents and the suitability of various raw materials are surveyed. Requirements on catalysts are stated and industrially useful catalysts are described and the effect of coal pre-treatment on hydrogenation characteristics are considered.

High-Pressure Hydrogenation of Carbonaceous Matter

PART II

PRIMARY HYDROGENATION IN THE LIQUID PHASE

PETER W. SHERWOOD
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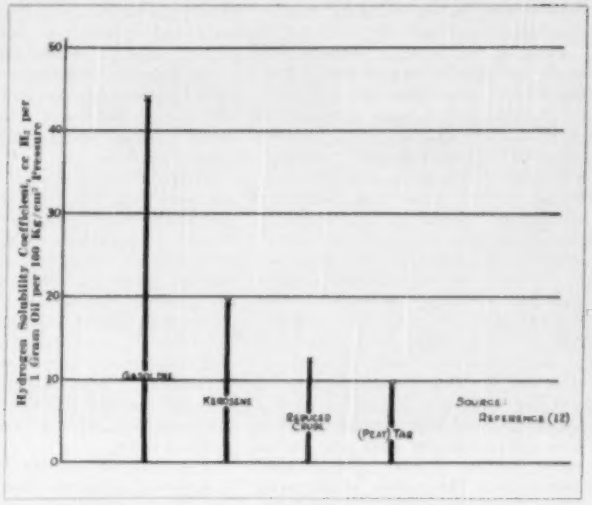


Figure 1

WHEN coal, tars, or oils are heated to temperatures above 750° F., a breakdown of the molecular structure occurs and considerable quantities of hydrogen and volatile oils are liberated. As a result the residual carbonaceous matter has a higher carbon/hydrogen ratio than the starting material.

The exact mechanism by which this breakdown occurs is far from being clearly understood. In broad outline, the primary products of the carbonization processes are believed to be highly unsaturated fragments of the original molecules, which exhibit a strong tendency to repolymerize immediately under the drastic conditions of temperature at which they are formed. The presence of hydrogen at a sufficiently high partial pressure tends to minimize the secondary reaction by saturating the breakdown products almost as soon as they are formed.

Under hydrogenative conditions there are thus two simultaneous and opposing tendencies: Polymerization and hydrogenation of the reactive components of the system. The objective of proper hydrogenation technique is to minimize the polymerization tendency toward the formation of the highly condensed aromatic compounds ("asphalts" and benzene-insoluble compounds), which are exceedingly stable and refractory to further processing, and thus represent a yield loss. At the same time, primary aromatics are to be hydrogenated and rendered into a form more amenable to splitting reactions. There are only two ways in which the formation of asphalts can be reduced at the temperatures of operation which are common to low-temperature carbonization and to primary hydrogenation (750-900° F.). These approaches are an increase in the partial pressure of hydrogen and the addition of hydrogenation catalysts. Both methods have the same fundamental aim: to favor the hydrogenation reaction over secondary condensations and polymerizations, and to promote the speed of hydrogenation of extant highly aromatic asphalts to more naphthenic compounds which are less refractory to the desired splitting reactions.

It is self-evident that primary hydrogenation products which have been produced in the liquid phase constitute in themselves raw materials for further breakdown and hydrogenation reactions as long as they are exposed to the drastic liquefaction conditions. It might therefore be expected that a progressive breakdown of the molecular structure will occur and eventually nothing but gasoline and hydrocarbon gases (plus unconvertible residue) will leave the liquid phase. Such a mode of operation is possible but undesirable. The gasoline produced in the liquid phase has poor engine performance characteristics. It is furthermore produced with the simultaneous formation of large amounts of L.P. gases and methane which are an economic waste and consume large amounts of costly hydrogen uselessly.

In actual practice, it is therefore necessary to limit the formation of gasoline and gas in the liquid phase to the economically irreducible minimum and to concentrate on the production of middle oils which can be processed more feasibly under the more adequately controllable catalytic conditions of the vapor phase. Roughly stated, the liquid phase (in the case of coal hydrogenation) starts with a raw material of molecular weight generally exceeding 1000. The heavy oil produced and retained in the h.o.l.d.[1] has a molecular weight of about 400 while the middle oil which is the main product leaving the liquid phase averages 180. The vapor phase reduces this last-named material to gasoline with an average molecular weight of 100.[2]

The preferential production of middle oil is brought about by reducing the conversion per pass and recycling the heavy oil together with a portion of the asphaltene matter, after the middle oil has been topped off. In this way, middle oil is exposed to the drastic conditions of the liquid phase for only a limited period. An additional saving feature is the increasing thermal stability of oils as the molecular weight decreases.

Solvents for Coal

According to Erasmus,[3] coal is a polymer consisting primarily of relatively small aromatic units of about 10 carbons each, some of which are linked through aliphatic- and some through aromatic-ether-oxygen bonds.

This highly complicated substance has resisted all attempts to dissolution without molecular breakdown. It has, however, been possible to bring about the dissolution of the greater (organic) portion of coal at elevated temperatures using certain solvents which are capable of giving up hydrogen to the solute.

The subject of solvation of coal has been discussed in considerable detail by Kiebler.[4] It is here only necessary to state some of the highlights which

have bearing on the industrial hydrogenation of coal and oils.

Probably the most important work on the solvation of coal is due to Pott and Broche[5] who found that a mixture of tetralin, phenol, and naphthalene in a weight ratio of 2:1:2 was the most satisfactory solvent for bituminous coal. A plant was constructed by Ruhrol at Bottrop-Welheim, Germany, which was intended for operation by the Pott-Broche Process. The original intention was to operate the extraction at 770° F. and 100-150 atmospheres (the vapor pressure of the solvent at this temperature), followed by filtration of the product. The filtrate was to be subjected to further hydrogenation for the eventual production of gasoline. In this way it was hoped to avoid the residue processing which is even today still the weak spot in the entire process of coal hydrogenation (see below). The process, as originally planned, never reached industrial maturity. Difficulties encountered in the filtration were great, and the hydrogenation of the extract presented outstanding difficulties. Instead, the process was called upon for the production of a high-grade electrode coke by the carbonization of the filtrate. More will be said about this below. Ruhrol's gasoline production was eventually based on the operation of a normal 10,300 psi. liquid phase with standard residue processing methods.

It was, however, found at Ruhrol, that a middle oil obtained by the hydrogenation of pitch could be successfully substituted for the expensive synthetic Pott-Broche solvent described above.

According to Orchin and Storch,[6] the solvation by the Pott-Broche process involves a mild hydrogenolysis of carbon-to-oxygen linkages by the hydrogen available from the hydroaromatic solvent and dissociation of the coal or primary products from the coal due to hydrogen bonding of the hydroxylated solvent. The liquefaction of coal in the presence of high pressure hydrogen proceeds equally well with an aromatic or hydroaromatic compound, but best results are achieved with vehicles containing a hydroxyl group attached to an aromatic ring.

In proof of their statement, Orchin and Storch demonstrated that other solvents (e.g., 1,2,3,4-tetrahydro-5-hydroxynaphthalene) satisfying these requirements gave liquefaction yields of 80 percent and are thus equivalent to the solvating power of the Pott-Broche mixture.

As is seen also, the demands on the solvent in the presence of high-pressure hydrogen are less stringent. Certainly the oils produced in the course of hydrogenation are sufficiently phenolic and aromatic to act as satisfactory solvents. These oils are the vehicles for hydrogenation processes ranging from extractive hydrogenation (for the production of primary bitumen free of ash) to gasoline synthesis at high pressures.

Other more generalized theories have been proposed. According to Pertierra,[7] the dissolving power of a coal solvent is approximately proportional to its internal pressure. Dyakova[8] finds that by operating with coal tar, fuel oil, tetralin, etc., in the presence of 20-40 atmospheres hydrogen and at 710-800° F. good solvation of coal and simultaneous decomposition can be attained. Up to 40 percent of the starting material is reported to be converted to a product boiling in the gasoline range.

A proper solvent for liquid-phase hydrogenation has one other important property—the ability to act as a good solvent for hydrogen. It has become quite evident that the hydrogenation of coal takes place at the interface between the coal and the oil in which it is suspended and only to a much lesser extent between the coal and the gaseous phase. Three important variables affect the solubility of hydrogen in a solvent: 1) Temperature—unlike most other gases, hydrogen becomes more soluble in hydrocarbon oils as the temperature is raised. This characteristic is of prime significance to the process. 2) Pressure — Ipatieff and Levin[9] find that the solubility of hydrogen in hydrocarbons obeys Henry's law at low pressures, but that the solubility coefficient increases with increasing pressure at high hydrogen pressures. 3) Hydrogen is more soluble in a hydrogen-rich than in a hydrogen-poor oil (Figure 1). This means that conditions for liquid-phase hydrogenation become more favorable as the reaction progresses and the oils become more naphthenic.

Suitability of Various Raw Materials for Hydrogenation

A vast variety of carbonaceous materials is capable of being upgraded to oils of lower molecular weight and higher hydrogen content by high-pressure hydrogenation. This does not mean, however, that all raw materials can be subjected to the process with equal ease and with similar degree of success. Conditions in the liquid phase must be adapted to the nature of the raw material and to its amenability to hydrogenation.

Among the main classes which may be looked upon as hydrogenation raw materials of primary importance, the ease of hydrogenation decreases in the order: Petroleum residues, tars, young coals (brown coals and lignites), bituminous coals and pitches.

One of the largest single cost items in high-pressure hydrogenation is compressed hydrogen which accounts for some 40 percent of the total cost of coal hydrogenation. It is, therefore, clear that, from a processing cost point of view, the conversion of raw materials which already have a comparatively high hydrogen/carbon ratio is most favorable. At the same time, it is seen from the above enumeration, that such materials are, in general most readily processed. The picture is particularly favorable in the hydrogenation of low-temperature carbonization tar and petroleum residues which can be converted wholly to oil-soluble, asphalt-free products which are practically completely devoid of ash. Residue processing is therefore a minor item when such oils constitute the feed stock, and another major cost factor is avoided. On the other side of the ledger, there is the fact that petroleum oils and tars are not available in sufficient supply to be considered an adequate basis for a truly large-scale synthetic oil industry. As has been pointed out previously, such a large-scale effort will have to be based predominantly on coal.

Thus, while the hydrogenation of petroleum residues and tars is of great potential significance, it must be looked upon, both economically and technically, as a special case of the more difficult hydrogenation of coals which will be dealt with here in greater detail.

In evaluating the amenability of raw materials for high-pressure hydrogenation, four major results must be observed: a) *Conversion*—the percentage of moisture- and ash-free coal converted to liquid and gaseous products. This should be as great as possible. b) *Space Performance*—the weight of desired end product (e.g., gasoline plus middle oil plus heavy oil) expressed in pounds per cubic foot reaction space and hour. This quantity is an analogue of "space-time yield" factors employed in other catalytic processes, and should, of course, be high. c) *Asphalt content of heavy (recycle) oil.*—This quantity is low in the case of highly suitable raw materials. By definition, asphalt is the amount of organic material which is soluble in benzene but insoluble in a 60-90° C. petroleum ether. d) *Gas Formation*—This characteristic, which should be low, is a measure of the amount of undesired light gases formed. It may be expressed as a fraction of the total charge or, more commonly, as the ratio of the C-content of the gases to the C-content of certain products (us-

ually middle oil, gasoline, plus gas). In American practice L.P. gases (propane and butane) must be looked upon as an economic loss and they must be included in the amount of total gas formed.

The effect of various characteristics of the raw materials on these performance factors has been evaluated. The effect of ultimate analysis has been discussed by Sherwood[10] on the basis of data obtained at German plants. The carbon content of a coal has the controlling influence on its behavior during hydrogenation. Under similar operating conditions, an increase in carbon content of the coal means an increase in gas formation and asphalt, and a decrease in space performance. The effect of carbon content on percent conversion is less clearly defined.

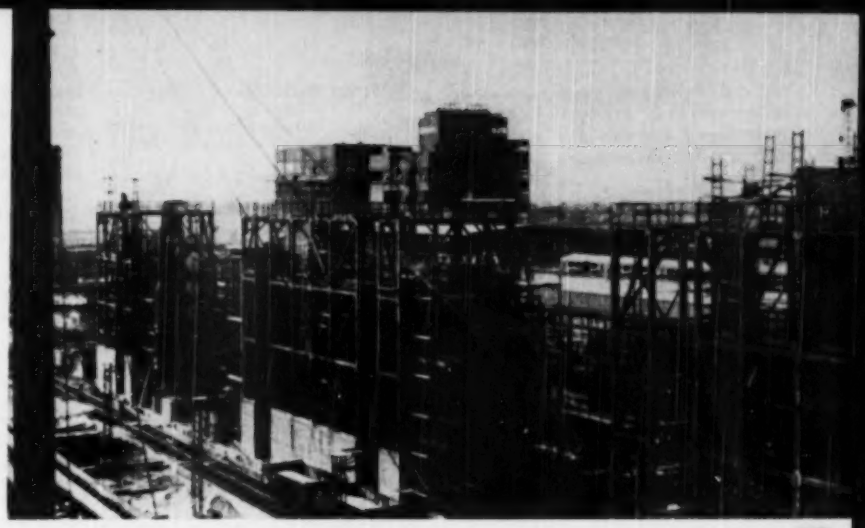
Certain correlations can also be obtained for oxygen content, degree of coalification, volatile matter, carbonization tar yield, and the presence of certain catalytic elements such as chlorine, sulfur and iron. In general, the following properties of coal are favorable for hydrogenation:

Low Values for	High Values for
C-content of amf. ‡ coal	Available H‡‡
O-content	Volatile components
Degree of coalification	Carbonization tar yield
Ash	Bitumen
Alkalinity	Catalytic elements:
CaO	iron
Alkalies	sulfur
	chlorine

‡ amf. means ash- and moisture-free.
‡‡ "Available" hydrogen is the amount of hydrogen in the amf. coal minus (⅛ of its oxygen content plus 3/14 of its nitrogen content).

In this connection, it must be understood that the interrelation of these various factors is important and that no one factor may be looked upon as a criterion in the absence of the others. These rules apply only for first evaluations. At the present state of knowledge, it is still essentially necessary to test hydrogenation raw materials empirically before selecting the most suitable conditions for their hydrogenation.

A large number of American coals have been tested for their hydrogenability by workers at the U. S. Bureau of Mines.[11] The experiments were carried out in the laboratory and conclusions to industrial hydrogenability of these coals must be drawn with caution. The work confirms the general rules outlined above. The important effect of carbon content on the suitability of coals for hydrogenation has also been determined in the case of British coals.[12]



High-Pressure Coal Hydrogenation Halls.

In a series of interesting autoclave experiments, Storch and coworkers[13,14] have hydrogenated the petrographic components of coal individually and find that they exhibit very clearly defined differences in the ease with which they can be subjected to hydrogenation. As defined by Thiessen,[15] coal is composed essentially of three classes of petrographic components which can be separated mechanically under the microscope: anthraxylon (vitrain), attritus, and fusain (for a definition of these terms, the reader is referred to Thiessen's publication or to any standard text on the chemistry of coal).

According to Storch, all common constitutents of low- or intermediate-rank coals, except fusain and opaque attritus, are liquefied almost completely, with little or no residue. Fusain and opaque attritus contain about 75 to 95 percent and 20 to 60 percent resistant matter, respectively. In the case of opaque attritus, the degree of liquefaction was found to be roughly proportional to the degree of opacity. A quantitative measure for the amount of residue to be expected from any particular sample of fusain or attritus has not been developed so far.

The combination of ultimate and proximate coal analysis and petrographic composition yield a good primary clue for the evaluation of the amenability of any selected coal to hydrogenation. None of the rules developed to date is, however, free of striking exceptions and care must be used in applying them.

In the hydrogenation of oils other than highly aromatic tars and pitches the conversion to benzene-soluble compounds is essentially complete and the presence of asphalts in the heavy oil is very low. The two characteristics which define the ease of hydrogenation are therefore the amount of gas formation and the space performance. Both of these factors are dependent on the hydrogen content and degree of aromaticity of the starting material. Highly aromatic stocks, low in hydrogen, such as coke oven tar and cracking residuum oils exhibit higher gas formation losses and require more reaction space than low temperature carbonization tars and topped virgin petroleum stocks.

The hydrogenation of some high-temperature tars and especially of highly aromatic pitches requires drastic conditions. Asphalt and gas formation are high in this special case. Such materials have been processed at 10,300 psi, at several plants.

Catalysts for the Liquid Phase

By definition, the principal products of liquid-phase coal hydrogenation are in order of decreasing molecular weight: Benzene-insoluble matter, asphalts (petroleum-ether insoluble compounds), heavy oil boiling above 635° F., middle oils in the boiling range 300-635° F., gasoline and hydrocarbon gases. The benzene-insoluble components (solids) and asphalts present in the heavy-oil let-down constitute largely a yield loss and a nuisance. Only very little of these reaction materials can be upgraded by recycling to the liquid phase. They merely take up valuable reaction space and present problems of deposition on the catalyst and walls of the liquid-phase converters. They must therefore be removed by an expensive residue processing operation, whose cost varies directly with the amount of these high-molecular compounds present in the heavy

oil and which may become well-nigh inoperable in the presence of excessive amounts of asphalts.

The primary function of the liquid-phase catalyst is to minimize asphalt and organic solids in the hydrogenation product. Its essential function is to promote the hydrogenation of these compounds in order to render them in a thermally less stable form, and to bring about the immediate hydrogenation of those unsaturated molecular fragments from the splitting reaction which may have a tendency to recondense into high-molecular compounds. The role of the liquid-phase catalyst in the splitting reactions is secondary; it is important only that the effect on reactions of this type is not adversely high, a property which would lead to the formation of excessive amounts of hydrocarbon gases.

The reaction time in the liquid phase is largely determined by the time required to reduce the asphalt and solids content to tolerable levels. By promoting the hydrogenation and consequent breakdown of these classes of compounds, an effective liquid-phase catalyst reduces the required reaction time and is thus able to save valuable reaction space. An important secondary effect of this is the reduction of gas formation because the primary breakdown products of the liquefaction process (heavy oil, middle oil, and gasoline) are exposed to the drastic splitting conditions for a comparatively short time only.

To define criteria for a satisfactory liquid-phase catalyst, the I. G. Farben central research laboratories at Ludwigshafen defined the following performance limits as being industrially still tolerable.[10] With small variations, these criteria may be considered universally applicable:

(1) **Conversion** (decrease in benzene-insoluble organic solids):
For brown coal and lignite:
Complete
For bituminous coal: 95-98 percent

(2) **Asphalt** in the recycle oil must not exceed 10 percent. The ratio of asphalt to total solids entering the carbonization furnaces (cf. Residue Processing) must not exceed 1:3. Otherwise operation of the furnaces becomes impossible.
All of the newly formed asphalt must be removable by the residue processing operation.

(3) **Gas formation:** For brown coal and lignite: not to exceed approximately 20 percent of the total middle oil plus gasoline plus gas formed during the reaction.
For bituminous coal: not to exceed approximately 24 percent on the same basis.

(4) **Space Performance** (Space-time yield):
The following minimum values are expected for coal hydrogenation:
At 4400 psi.: 9.4-15.6 pounds per cubic foot per hour
At 10,300 psi.: 15.6 pounds per cubic foot per hour
(These figures apply when gasoline and middle oil are the desired end products of the liquid phase. Operation for the primary production of heavy oil calls for higher throughput and space performance.)

It should be noted that these criteria apply to hydrogenation in a small continuous plant employed for the study of hydrogenation conditions for various coals and raw materials. On a large scale, conversion is generally somewhat lower than here indicated for reasons not entirely clear but probably connected with the relatively smaller surface effect of the large-scale converter walls.

As has already been pointed out above, almost the entire periodic table has been patented for catalytic use in the liquid phase. It will serve no useful purpose to go into details of the real and alleged performance data which have been reported for a great many materials. Certain catalytic combinations have been worked out for industrial usage both in England and Germany. These catalysts have been in actual operation for a number of years and are also intended for the early work at the new coal hydrogenation demonstration plant of the U. S. Bureau of Mines.

The following catalytic combinations have attained industrially successful status:[10]

a) For bituminous coal at 4400 psi.: tin oxalate and ammonium chloride. When this catalyst is employed, soda ash neutralization is necessary following the hot catchpot in order to avoid corrosion which is significant in the 480-660° F. temperature range. The soda ash is generally introduced in 20 percent excess in the form of an oil suspension.

Typical concentration: .06 percent tin oxalate, 1.15 percent ammonium chloride (based on hydrogenation coal).

b) Bituminous coal at 10,300 psi.: At the higher pressure the equilibrium: (aromatics) + H_2 = (hydroaromatics) is displaced toward the right. Therefore, higher temperatures can be employed before coking, excess asphalt, etc., appear. As a result of the higher permissible temperatures and the more strongly hydrogenating conditions, it becomes possible to use a cheaper and less active catalyst. Most customary under these conditions are iron catalysts, one important catalytic combination being Bayer mass + iron sulfate + sodium sulfide (Bayer mass is an iron-rich residue of bauxite refining obtained in the aluminum industry).

Typical concentration: 2 percent Bayer mass, 1.3 percent iron sulfate, .33 percent sodium sulfide (based on hydrogenation coal).

c) Lignites and brown coals are generally more amenable to hydrogenation. Even at 4400 psi., it is possible to use iron oxides successfully, often with the addition of sulfur or sodium sulfide.

Typical concentration: 6 percent iron oxide, 1.2 percent sulfur (based on hydrogenation coal).

d) Tars and oils are preferably catalyzed with iron sulfate and caustic soda on a carrier such as grude (an activated lignite semi-coke obtained as an undesired by-product in some types of gasification processes).

Typical concentration: .5-1 percent catalyst (based on make-up oil). Catalyst contains 5 percent ferrous sulfate and caustic soda in equivalent amounts.

The only other liquid-phase catalysts which show industrial promise are molybdenum in various forms for use with lignites and iodine for the hydrogenation of bituminous coal.

Carrier for Metal Base

It should be noted that catalyst concentration in the liquid phase is very dilute and that catalytic control under such conditions cannot be as complete as is possible over a fixed-bed catalyst. In order to assure satisfactory distribution of the catalyst throughout the reactor and to minimize its natural tendency toward settling out of the reaction phase, it is often necessary to provide a carrier for the metal base. In the case of coal, the solid components (ash and benzene-insoluble) of the raw material act as a natural carrier, but in the case of tars and oils an external carrier must be provided. Aside from "grude" which has already been mentioned, a number of other carriers such as floridin and hydrogenation residue (from coal operation) can be used effectively. Under suitable economic conditions, it is possible to hydrogenate coal and tar simultaneously, permitting the coal to act as catalyst carrier for the hydrogenation of both raw materials.

Aside from the demand for a favorable or neutral catalytic effect of the carrier, there are certain mechanical requirements which must be met by catalysts and catalyst carriers for the liquid phase. Of particular importance is the specific gravity of the material which should not exceed 2.0 to prevent

a tendency toward settling from the reaction slurry. The material should not have a tendency to deposit on the walls of converters or to cause encrustations in the preheaters and regenerators.

In the liquefaction of bituminous coals, an alkaline liquid phase has a definitely undesirable effect on the asphalt conversion. In brown coals, alkalinity is actually desirable.

It has therefore become customary to neutralize bituminous coals with alkaline ash before introduction into the liquid phase. The neutralization is generally carried out with sulfuric acid, whereby the final sulfuric acid concentration must be carefully controlled lest it promote a tendency toward polymerization which exceeds the beneficial effect on asphalt conversion. This polymerization-promoting tendency of sulfuric acid is also the reason why acidic tars and oils must be carefully neutralized before hydrogenation in the presence of iron sulfate catalyst.

It has been found that chlorine is an effective promoter toward the reduction of asphalt content in bituminous coal liquefaction. Under conditions where the use of chlorine is felt to be desirable (see above), this element is generally added in the form of ammonium chloride to avoid the occurrence of serious corrosion difficulties (note that elemental chlorine would be immediately reduced to hydrogen chloride under the conditions of hydrogenation—just as iron sulfate is immediately converted to the sulfide).

Sulfur is sometimes used as an auxiliary catalyst to improve the asphalt reduction. In at least one plant (Wesseling) elemental sulfur has had to be added to the brown coal paste for mechanical reasons: to prevent undue swelling of the coal when heated, a tendency which had caused plugging and operating troubles in the preheater.

Sodium sulfide has been found to exert a favorable effect on the gas formation. It exhibits some of the favorable effects of sulfur and can also be used to advantage for the neutralization of acidic coals.

Effect of Coal Pretreatment on Hydrogenation Characteristics

Since coals of high carbon content exhibit low hydrogenation amenability, attempts were made in German hydrogenation laboratories to influence liquefaction characteristics by reducing the carbon content of the raw material.

Mild oxidation of a bituminous coal by the action of air at 400° F. reduced the carbon content from 88.2 to 84.2 percent. At the same time, the oxygen content of the material increased. Asphalt conversion, splitting, and gas formation under hydrogenative conditions were improved somewhat.[10] More drastic oxidative treatment, however, resulted in an actual deterioration of the hydrogenation amenability of the coal.

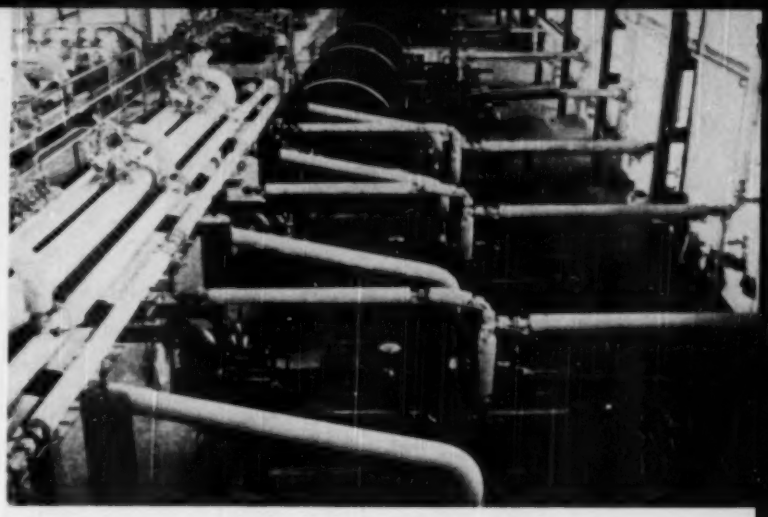
The effect of mild chlorination was also slightly favorable while drastic chlorination of the coal resulted in inferior hydrogenation performance.

These chemical pretreatment methods are not sufficiently favorable to promise any future industrial application. Work carried on along these lines may, however, add to our understanding of the reaction mechanisms involved in the high pressure hydrogenation process.

Whenever possible, coals should be deashed as completely as may be economically feasible before submitting them to liquid-phase hydrogenation. The cost of residue processing in coal hydrogenation is appreciable in any case and rises almost in exact proportion to the ash content of the starting material. Removal of the bulk of the ash by beneficiation is therefore preferable to permitting the ash to reach the carbonization furnaces. In this connection it should be noted that certain variants of the hydrogenation process are carried out for the precise purpose of obtaining a product completely free of ash, an objective which cannot be reached by beneficiation. Processes of this type yield a specialty product and will be discussed below.

The coal size entering the liquid phase is dictated almost entirely by mechanical considerations. It should be small enough to permit adequate pumping but should not be so small that the viscosity of the paste is raised excessively or that the cost of grinding becomes too great. In European practice, the coal is generally ground to approximately 80 percent through 65 mesh (Tyler scale).

Since the coal is generally ground together with the pasting oil, the presence of moisture may lead to the formation of emulsions. Generally, a water content of the paste below 6 percent is considered desirable to avoid these difficulties.[10] By proper design and operation of the milling equipment, it may, however, be possible to carry out the drying and grinding operations simultaneously. Such a design feature has been incorporated in the U. S. Bureau of Mines plant at Louisiana, Mo.[10] Results on its operation have not yet been made public.



A Battery of High-Pressure Paste Injection Pumps

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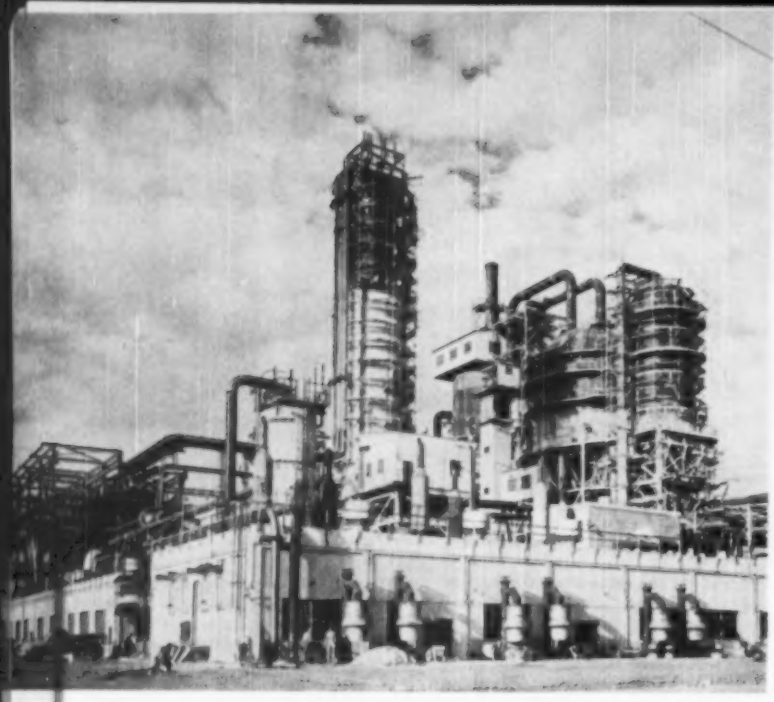
End of Part III. Part IV will appear in an early issue.



The catalytic cracking units nears completion. It will process 24,000 barrels of gas oils per day. With the completion of this new unit, The Texas Company will have seven catalytic cracking units operating in six different geographic areas.

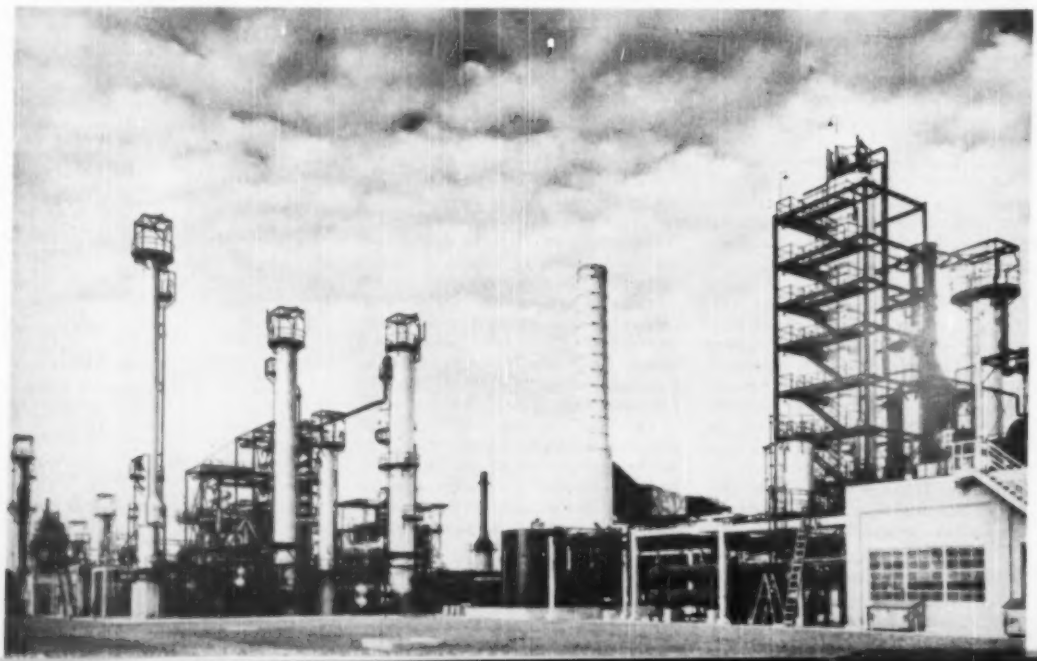
Texaco Opens New Plant on Eastern Seaboard

THE Texas Company's new refinery, the Eagle Point Works, located at Westville, N. J., has a rated capacity of 40,000 barrels of crude oil per calendar day. Actual operations are expected to exceed this figure.

Eagle Point is one of the few oil refineries in the United States which has been built completely "from scratch." It was laid out so that the rated thruput can be multiplied five times, if future product demand requires such expansion.

The present facilities include: An atmospheric and vacuum crude pipe still, designed to process 40,000 barrels of crude oil per calendar day; a fluid catalytic cracking unit, rated at about 25,000 barrels per day; a thermal reforming unit, of 10,000 barrels per day capacity; a catalytic polymerization unit; a furfural refining unit of The Texas Company's own design, which will process high-grade diesel and furnace oils; a Linde treating unit for processing gasoline components and furnace oil;

NEW OPERATING UNITS—At the right is the furfural unit—a Texaco-developed process that removes impurities from oils by means of solvent refining methods. The center towers are in the thermal reforming unit, which changes heavy naphtha. Coil condition of 1000° F. and 750 psig. are used. At the far left is the catalytic polymerization unit using charge-stock gases from the catalytic cracking unit, transforming them into high-octane blending stock for motor fuels.



Across the Delaware River from the Philadelphia Navy Yard, a new oil refinery has been placed in operation to provide high-octane gasolines and heating oils to the Eastern Seaboard.

a steam and electric power generating plant, consisting of three 275,000-pounds-per-hour steam boilers, generating steam at 900 pounds, and two 7500-kw. turbo-generators, plus necessary water treating facilities.

The new refinery is located on the Delaware River at Westville, N. J., eight miles southwest of Camden, directly across the river from the Philadelphia Navy Yard. The site covers 1600 acres, with 2¼ miles of deep-water frontage. Docking facilities provide for simultaneous handling of three ocean-going tankers and three barges. All crude will be brought in by tanker. Finished products will be shipped by water, truck, and rail.

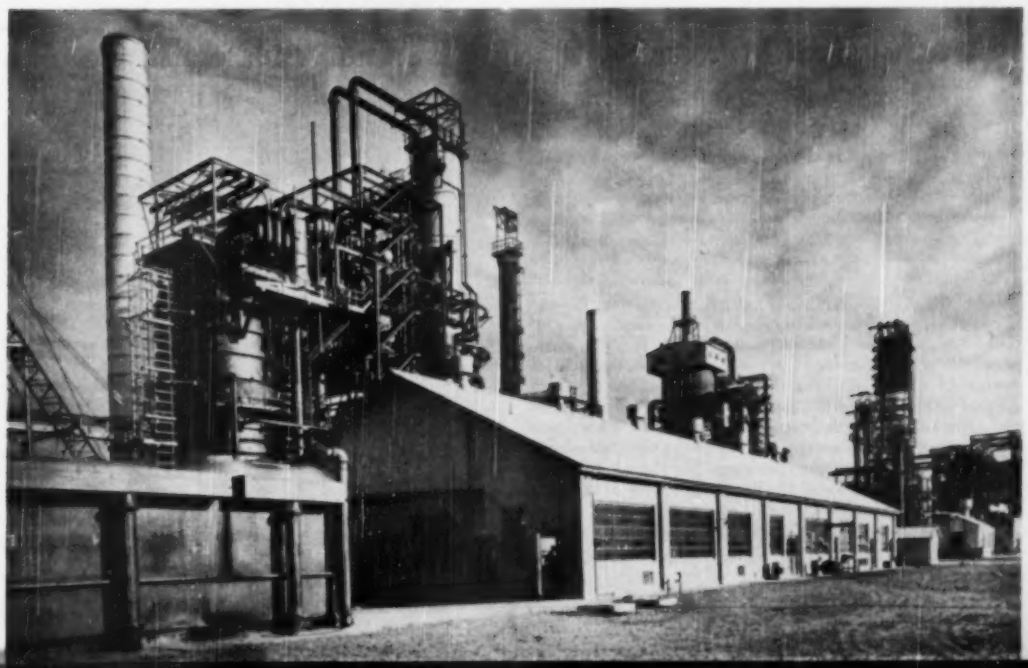
The refinery has been designed to process motor gasolines, diesel and furnace fuels. Under present plans it will not process lubricating oils.

At present the company plans to employ about 600 workers. Of these, about 125 are highly skilled technicians transferred from other refineries.

The area from Jersey City to Wilmington is rapidly becoming the country's No. 2 oil refining center, second only to the Gulf Coast area. Nearly $300 million is being spent on refineries in this area. When this program is completed, the industry will be able to process nearly a million barrels of oil per day, an increase of more than 25 percent over 1946.

Growing demands for oil products along East Coast brought about this 25 percent increase in East Coast refining capacity. The oil industry will employ more than 21,000 workers in the area between Jersey City and Wilmington, and will be able to process almost 1,000,000 barrels of oil per day in these refineries.

CRUDE UNIT—This atmospheric and vacuum pipe still is designed to process 40,000 barrels of crude oil per day. Products are gas, light and heavy straight run naphthas, gas-oil, and various residual products—all going to other units for further processing. The unit was designed to process high-sulphur crudes now coming to refineries in increasing quantities.



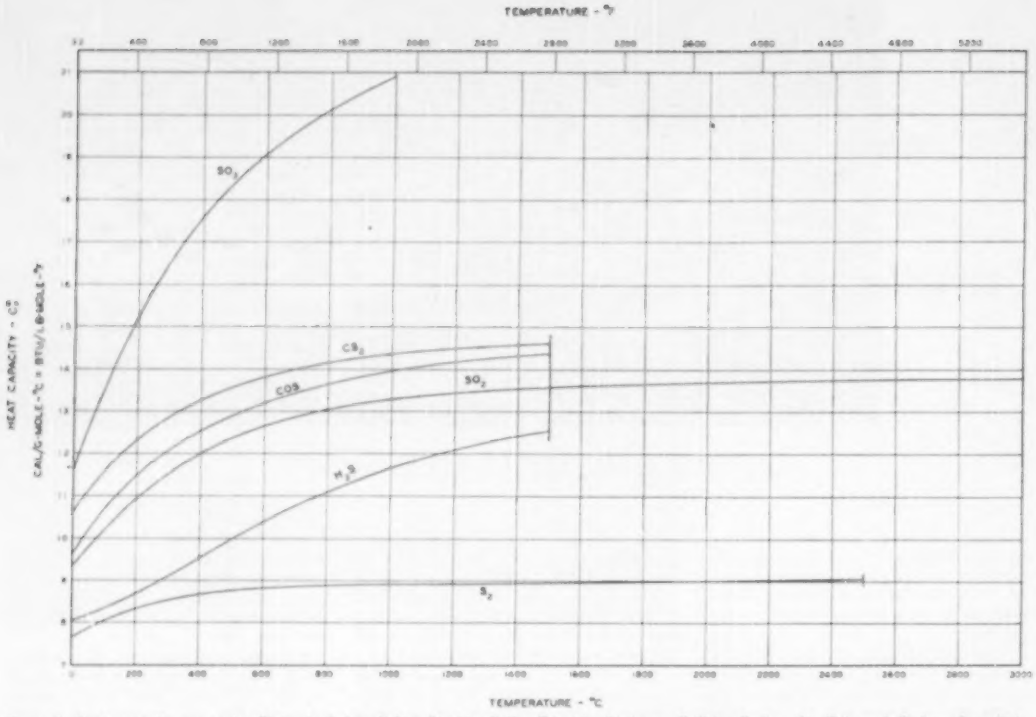


Figure 1. Heat capacity curves for Diatomic Sulfur, Sulfur Dioxide, Sulfur Trioxide, Hydrogen Sulfide, Carbon Disulfide and Carbon Oxysulfide.

THERMOCHEMISTRY for the Petrochemical Industry

Part VIII—Sulfur Compounds

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SULFUR COMPOUNDS are of frequent concern to engineers working with petroleum process plant calculations and operations. The increasing percentages of high-sulfur crude oils now being charged to stills and the wider utilization of sour field gases suggests that the thermodynamic properties of the sulfur compounds, discussed in this article will be of considerable utility. Earlier articles[16, 17, 18, 19, 20, 21, 22] have presented the thermodynamic properties of the principal hydrocarbons and of the combustion gases.

Dr. Kobe is professor of chemical engineering at the University of Texas and Mr. Long, formerly a Celanese fellow at Austin, is now connected with Johns-Manville.

AN IMPORTANT and interesting group of compounds is that formed by diatomic sulfur, sulfur dioxide, sulfur trioxide, hydrogen sulfide, carbon disulfide and carbon oxysulfide. As is evidenced by Table 1. the amount of

TABLE 1
Reported Heat Capacities of Sulfur Compounds

Compound	Temperature Range	Method	Workers	Reference
S_2	100 to 5000°K.	Spectroscopic	Godnev	8
			Godnev and Suetdin	9
SO_2	20°C.	Velocity of sound	Masson	23
	15 to 200°C.	Calorimetric	Regnault	27
	15°C.	Calorimetric	Cazin	4
	20°C.	Calorimetric	Muller	25
	20°C.	Velocity of sound	Thibaut	34
	20°C.	Velocity of sound	Scholer	29
	0°C.	Velocity of sound	Schweikert	30
	13°C.	Velocity of sound	Partington and Cant	26
	0 to 1900°K.	Spectroscopic	Cross	6
	298 to 3000°K.	Spectroscopic	Kelley	15
	300 to 2000°K.	Spectroscopic	Bryant	2
	0 to 3000°C.	Spectroscopic	Justi	11
SO_3	800 to 1200°K.	Spectroscopic	Stevenson	32
	298 to 1200°K.	Spectroscopic	Stockmayer, Kavanagh and Mickley	33
H_2S	20°C.	Velocity of sound	Capstick	3
	20°C.	Velocity of sound	Masson	23
	20 to 200°C.	Calorimetric	Regnault	27
	216 to 278°K.	Calorimetric	Millar	24
	30 to 110°C.	Calorimetric	Felsing and Drake	7
	0 to 300°C.	Spectroscopic	Bruckner	1
	0 to 3000°C.	Spectroscopic	Justi	12
	298 to 1800°K.	Spectroscopic	Cross	5
CS_2	14°C.	Velocity of sound	Capstick	3
	100°C.	Velocity of sound	Stevens	31
	18°C.	Velocity of sound	Thibaut	34
	30°C.	Calorimetric	Muller	25
	25°C.	Calorimetric	Wiedemann	35
	70 to 194°C.	Calorimetric	Regnault	27
	298 to 1800°K.	Spectroscopic	Cross	6
COS	298 to 1800°K.	Spectroscopic	Cross	6

TABLE 2

Free Energies of Formation, Heats of Formation, and Heats of Combustion of Sulfur Compounds at 25° C.[1]

Compound	Molecular Weight	ΔG_f° Cal./g-mole	ΔH_f° Cal./g-mole	$-\Delta H_c^\circ$, cal./g-mole[2] $SO_2(g)$, $CO_2(g)$, $H_2O(g)$	$SO_2(g)$, $CO_2(g)$, $H_2O(l)$
S_2	64.132	19,440[3]	29,860	171,780	171,780
SO_2	64.066	−71,790	−70,960	0	0
SO_3	80.066	−88,520	−94,450		
H_2S	34.082	−7,892	−4,815	123,943	134,462
CS_2	76.142	15,550	27,550	263,522	263,522
COS	60.076	−40,440	−32,890	132,212	132,313

[1] ΔH_f° and ΔG_f° represent the change in the heat content (enthalpy) and free energy, respectively, for the formation of the gaseous compounds from the elements, with all the reactants and products in their appropriate standard reference states. The standard reference state for sulfur is the rhombic form.

[2] $-\Delta H_c^\circ$ represents the heat evolved at 25°C. and constant pressure in the combustion of the gaseous compounds to form the products indicated with all the reactants and products in their appropriate standard reference states.

[3] The value of ΔG_f° for S_2 is taken from Gordon.[10] The remaining data of this table are from the National Bureau of Standards' **Selected Values of Chemical Thermodynamic Properties.**[10] The standard reference state for sulfur is the solid rhombic form at 25°C.

TABLE 3

Heat Capacities of Sulfur Compounds
cal./g-mole · °C.

°C.	S_2	SO_2	SO_3	H_2S	CS_2	COS
0	7.643	9.31	11.60	8.06	10.61	9.59
18	7.728	9.46	11.87	8.11	10.82	9.83
20	7.757	9.52	12.12	8.12	10.91	9.92
100	8.046	10.17	13.57	8.36	11.64	10.71
200	8.318	10.94	15.24	8.70	12.36	11.49
300	8.504	11.53	16.58	9.11	12.89	12.08
400	8.627	12.03	17.62	9.55	13.28	12.53
500	8.706	12.38	18.42	9.99	13.58	12.90
600	8.765	12.65	19.06	10.39	13.81	13.19
700	8.812	12.86	19.62	10.76	13.98	13.43
800	8.850	13.02	20.08	11.09	14.12	13.64
900	8.880	13.15	20.49	11.35	14.24	13.80
1000	8.902	13.25	20.85	11.65	14.33	13.94
1100	8.920	13.34	....	11.89	14.40	14.05
1200	8.935	13.41	....	12.09	14.46	14.15
1300	8.948	13.46	....	12.27	14.52	14.23
1400	8.960	13.51	....	12.41	14.56	14.30
1500	8.972	13.56	....	12.54	14.60	14.37
2000	9.024	13.69	....	....	....	....
2500	9.069	13.76	....	....	....	....
3000	....	13.79	....	....	....	....

TABLE 4

Heat Capacities of Sulfur Compounds
cal./g-mole · °K.

°K.	S_2	SO_2	SO_3	H_2S	CS_2	COS
273	7.643	9.31	11.60	8.06	10.61	9.59
291	7.728	9.46	11.87	8.11	10.82	9.83
293	7.737	9.52	12.12	8.12	10.91	9.92
300	7.763	9.54	12.18	8.12	10.93	9.94
400	8.127	10.40	14.04	8.42	11.85	10.95
500	8.376	11.11	15.64	8.80	12.53	11.65
600	8.543	11.68	16.89	9.24	13.00	12.21
700	8.652	12.13	17.85	9.67	13.37	12.64
800	8.724	12.46	18.61	10.09	13.65	12.98
900	8.779	12.71	19.23	10.48	13.86	13.26
1000	8.823	12.91	19.75	10.85	14.02	13.49
1100	8.860	13.06	20.20	11.17	14.15	13.68
1200	8.889	13.18	20.59	11.46	14.26	13.84
1300	8.910	13.28	20.94	11.72	14.35	13.97
1400	8.925	13.36	....	11.94	14.42	14.08
1500	8.938	13.42	....	12.13	14.48	14.17
1600	8.950	13.48	....	12.30	14.53	14.25
1700	8.962	13.53	....	12.45	14.57	14.32
1800	8.974	13.57	....	12.58	14.61	14.38
1900	8.986	13.60	....	....	....	....
2000	8.997	13.62	....	....	....	....
2500	9.046	13.73	....	....	....	....
3000	9.086	13.78	....	....	....	....

TABLE 5

Heat Capacities of Sulfur Compounds
Btu./lb.-mole · °F.

°F.	S_2	SO_2	SO_3	H_2S	CS_2	COS
32	7.643	9.31	11.60	8.06	10.61	9.59
60	7.712	9.43	11.92	8.09	10.80	9.80
77	7.757	9.52	12.12	8.12	10.91	9.92
100	7.811	9.62	12.37	8.15	11.07	10.06
200	8.023	10.12	13.45	8.31	11.59	10.64
300	8.191	10.57	14.42	8.50	12.02	11.13
400	8.328	10.97	15.31	8.71	12.39	11.52
500	8.438	11.31	16.09	8.94	12.70	11.85
600	8.527	11.62	16.77	9.18	12.96	12.16
700	8.598	11.90	17.35	9.42	13.18	12.41
800	8.653	12.13	17.85	9.67	13.36	12.63
900	8.696	12.33	18.29	9.91	13.55	12.83
1000	8.732	12.49	18.69	10.14	13.68	13.02
1100	8.762	12.63	19.04	10.37	13.80	13.17
1200	8.789	12.76	19.35	10.58	13.90	13.32
1300	8.814	12.86	19.64	10.77	13.98	13.44
1400	8.836	12.96	19.90	10.95	14.07	13.55
1500	8.856	13.04	20.15	11.14	14.15	13.67
1600	8.874	13.11	20.38	11.30	14.21	13.76
1700	8.889	13.18	20.59	11.46	14.27	13.84
1800	8.902	13.24	20.79	11.61	14.33	13.92
1900	8.912	13.29	....	11.75	14.38	13.99
2000	8.921	13.33	....	11.88	14.39	14.04
2100	8.929	13.37	....	11.99	14.43	14.10
2200	8.936	13.41	....	12.09	14.44	14.15
2300	8.943	13.43	....	12.37	14.53	14.20
3000	8.968	13.50	....	....	....	....
3500	9.016	13.67	....	....	....	....
4000	9.041	13.73	....	....	....	....
4500	9.066	13.76	....	....	....	....
5000	9.088	13.78	....	....	....	....

TABLE 6

Heat Capacities of Sulfur Compounds
Btu./lb.-mole · °R.

°R.	S_2	SO_2	SO_3	H_2S	CS_2	COS
492	7.643	9.31	11.60	8.06	10.61	9.59
500	7.660	9.35	11.70	8.07	10.66	9.65
520	7.712	9.44	11.92	8.09	10.80	9.80
537	7.757	9.52	12.12	8.12	10.91	9.92
600	7.904	9.83	12.81	8.21	11.28	10.30
700	8.082	10.30	13.85	8.35	11.80	10.84
800	8.250	10.73	14.79	8.58	12.17	11.30
900	8.376	11.11	15.64	8.80	12.51	11.68
1000	8.477	11.43	16.37	9.04	12.80	11.98
1100	8.560	11.72	17.00	9.28	13.06	12.27
1200	8.630	11.99	17.56	9.53	13.25	12.51
1300	8.671	12.21	18.03	9.78	13.43	12.71
1400	8.710	12.39	18.45	10.00	13.59	12.91
1500	8.744	12.55	18.83	10.25	13.75	13.09
1600	8.773	12.69	19.17	10.45	13.84	13.23
1700	8.799	12.80	19.48	10.65	13.93	13.37
1800	8.823	12.90	19.75	10.85	14.02	13.49
1900	8.844	12.99	20.00	11.04	14.10	13.60
2000	8.863	13.07	20.24	11.20	14.17	13.71
2100	8.880	13.14	20.47	11.37	14.23	13.79
2200	8.894	13.20	20.67	11.52	14.29	13.87
2300	8.906	13.25	....	11.67	14.34	13.95
2400	8.916	13.31	....	11.79	14.37	14.01
2500	8.924	13.35	....	11.92	14.40	14.06
3000	8.959	13.51	....	12.40	14.56	14.29
3500	8.991	13.61	....	....	....	....
4000	9.019	13.67	....	....	....	....
4500	9.043	13.73	....	....	....	....
5000	9.070	13.76	....	....	....	....

energy expended toward the determination of their thermodynamic properties varies considerably from compound to compound.

For a simple molecule like diatomic sulfur the spectroscopic heat capacities may be used with confidence even without calorimetric data for substantiation. The statistical calculations of Godnev[8] and Godnev and Sverdlin[9] are reliable. No other heat capacity data for diatomic sulfur appear in the literature. However, Kelley[13] repeated the calculations and results to within a tenth of a percent. Calorimetric data are completely absent due to experimental difficulties caused by the complex equilibria among S, S_2, S_4, S_6 and S_8. Kelley[14] has calculated the heat capacity of monatomic sulfur, but inadequate data or knowledge prevent satisfactory statistical treatment for the polymers of sulfur higher than S_2. The reference state for sulfur is taken as the solid rhombic form at 25° C. for the standard heat and free energy of formation for S_2 in Table 2.

Sulfur dioxide has a long history and this is reflected in the considerable amount of experimental work shown in Table 1. The four spectroscopic sources, Cross,[6] Kelley,[13] Bryant[2] and Justi,[11] are in essentially complete agreement. Any of these sources may be used without a significant difference. Bryant did not show his actual results but merely said that his empirical equation values were compared to statistical values and then gave his statistical method.

The heat capacity data for sulfur trioxide are very limited. The first values were calculated by Stevenson.[12]

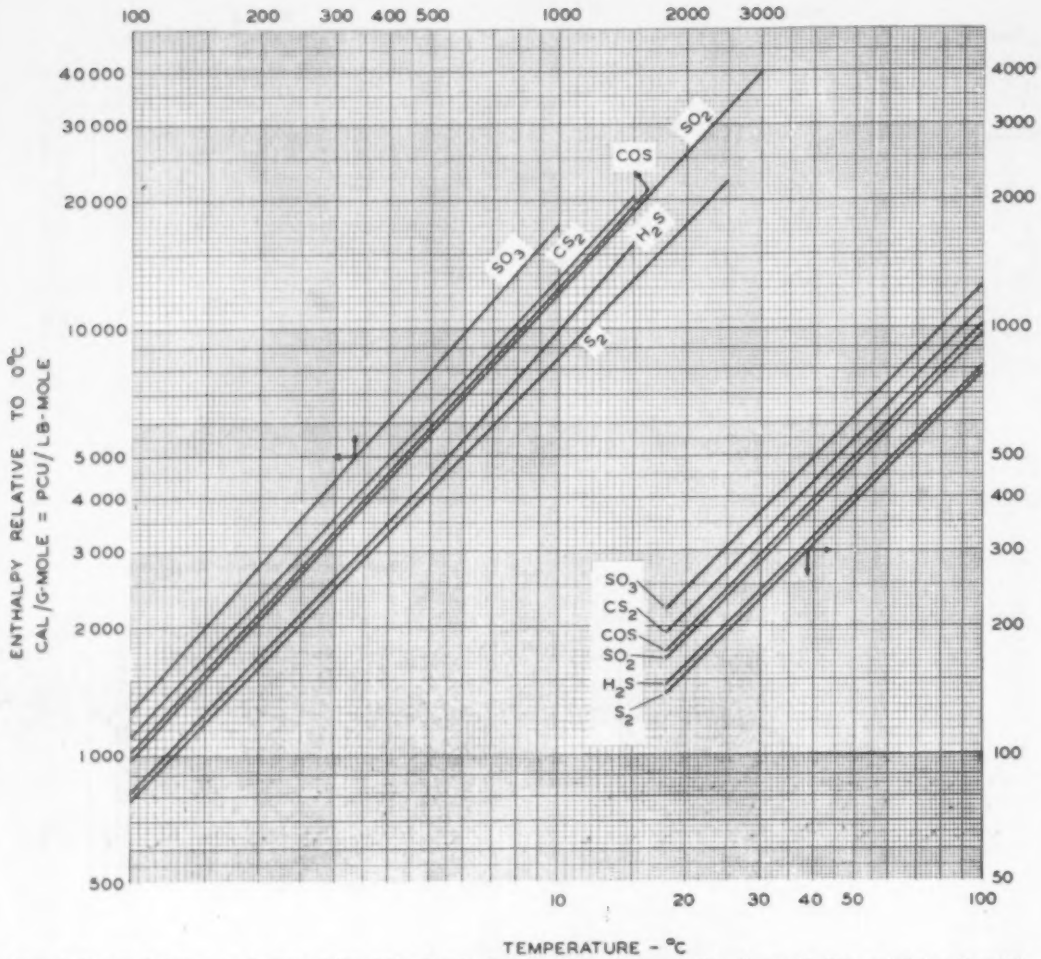

Figure 2. Relative Enthalpies for Diatomic Sulfur, Sulfur Dioxide, Sulfur Trioxide, Hydrogen Sulfide, Carbon Disulfide and Carbon Oxysulfide. Multiply readings in Pcu./lb.-mole by 1.8 to obtain Btu./lb.-mole.

TABLE 7
Enthalpies of Sulfur Compounds
cal./g-mole

°C.	S_2	SO_2	SO_3	H_2S	CS_2	COS
0	0.0	0.0	0.0	0.0	0.0	0.0
18	138.6	168.8	220.	145.2	193.0	175.7
25	192.4	235.3	300.	201.9	269.1	244.8
100	786.5	974.	1261.	820.	1116.	1018.
200	1606.	2030.	2704.	1673.	2318.	2127.
300	2447.	3188.	4297.	2563.	3582.	3367.
400	3304.	4358.	6008.	3496.	4892.	4538.
500	4171.	5555.	7813.	4473.	6236.	5810.
600	5045.	6810.	9689.	5492.	7606.	7114.
700	5924.	8085.	11630.	6594.	8996.	8446.
800	6807.	9376.	13610.	7686.	10400.	9799.
900	7694.	10680.	15640.	8808.	11820.	11180.
1000	8583.	12000.	17710.	9958.	13250.	12570.
1100	9474.	13330.	.....	11140.	14690.	13980.
1200	10360.	14660.	.....	12330.	16130.	15370.
1300	11260.	16000.	.....	13580.	17580.	16790.
1400	12160.	17360.	.....	14790.	19030.	18220.
1500	13060.	18720.	.....	16030.	20490.	19660.
2000	17550.	25540.	.....	.....	.....	.....
2500	22080.	32400.	.....	.....	.....	.....
3000	.....	39300.	.....	.....	.....	.....

TABLE 8
Enthalpies of Sulfur Compounds
cal./g-mole

°K.	S_2	SO_2	SO_3	H_2S	CS_2	COS
223	0.0	0.0	0.0	0.0	0.0	0.0
291	138.6	168.8	215.	145.2	193.0	175.7
298	192.4	235.3	300.	202.0	269.1	244.8
300	207.9	254.4	320.	217.4	290.9	264.2
400	1003.	1251.	1640.	1045.	1433.	1311.
500	1826.	2329.	3115.	1967.	2653.	11443.
600	2675.	3469.	4740.	2809.	3933.	3935.
700	3535.	4661.	6490.	3754.	5252.	4878.
800	4404.	5891.	8305.	4742.	6604.	6159.
900	5279.	7150.	10200.	5771.	7980.	7572.
1000	6159.	8431.	12150.	6838.	9374.	8910.
1100	7042.	9729.	14150.	7939.	10780.	10260.
1200	7929.	11040.	16190.	9071.	12200.	11650.
1300	8816.	12360.	18280.	10230.	13630.	13050.
1400	9711.	13700.	.....	11410.	15070.	14450.
1500	10605.	15040.	.....	12630.	16530.	15860.
1600	11500.	16340.	.....	13840.	17970.	17280.
1700	12400.	17730.	.....	15080.	19430.	18720.
1800	13290.	19090.	.....	16330.	20880.	20150.
1900	14190.	20440.	.....	.....	.....	.....
2000	15090.	21810.	.....	.....	.....	.....
2500	19600.	28630.	.....	.....	.....	.....
3000	24130.	35530.	.....	.....	.....	.....

At that time Stockmayer, Kavanagh and Mickley[33] were engaged in the same work. Because they had access to Stevenson's calculation before publication and because they improved upon his work by including anharmonicity contributions, Stevenson's data were withheld from journal

TABLE 9

Enthalpies of Sulfur Compounds
Btu./lb.-mole

°F.	S_2	SO_2	SO_3	H_2S	CS_2	COS
32	0.0	0.0	0.0	0.0	0.0	0.0
60	215.2	262.6	330.	226.0	300.4	217.7
77	346.3	423.9	530.	363.8	484.4	440.6
100	526.9	644.6	823.	551.6	738.6	675.2
200	1314.	1603.	2115.	1375.	1873.	1711.
300	2129.	2607.	3500.	2216.	3054.	2799.
400	2955.	3743.	4995.	3077.	4275.	3933.
500	3793.	4858.	6560.	3960.	5530.	5091.
600	4642.	6004.	8200.	4866.	6814.	6263.
700	5498.	7181.	9915.	5796.	8121.	7451.
800	6359.	8386.	11680.	6751.	9449.	8704.
900	7237.	9619.	13480.	7730.	10790.	10000.
1000	8080.	10880.	15320.	8732.	12150.	11330.
1100	8974.	12100.	17210.	9757.	13530.	12660.
1200	9851.	13370.	19140.	10800.	14910.	13990.
1300	10730.	14660.	21090.	11870.	16310.	15330.
1400	11610.	15950.	23070.	12960.	17710.	16680.
1500	12500.	17250.	25070.	14060.	19130.	18040.
1600	13390.	18550.	27100.	15180.	20540.	19410.
1700	14270.	19860.	29140.	16320.	21960.	20790.
1800	15160.	21180.	31230.	17470.	23390.	22180.
1900	16050.	22510.	....	18640.	24830.	23560.
2000	16940.	23850.	....	19830.	26270.	24960.
2100	17840.	25190.	....	21030.	27710.	26380.
2200	18730.	26530.	....	22250.	29150.	27800.
2300	21410.	30550.	....	25980.	33510.	32080.
2400	23990.	37340.	....	....	....	....
2500	30400.	44180.	....	....	....	....
3000	34020.	51030.	....	....	....	....
4500	39440.	57910.	....	....	....	....
5000	43980.	64780.	....	....	....	....

TABLE 10

Enthalpies of Sulfur Compounds
Btu./lb.-mole

°R.	S_2	SO_2	SO_3	H_2S	CS_2	COS
492	0.0	0.0	0.0	0.0	0.0	0.0
500	61.2	74.6	93.2	66.9	85.1	77.1
540	215.2	262.6	330.	226.5	300.4	271.7
537	346.3	423.9	530.	365.7	484.4	440.6
600	840.0	1034.	1320.	880.2	1188.	1077.
700	1641.	2041.	2660.	1710.	2342.	2135.
800	2458.	3094.	4090.	2558.	3541.	3243.
900	3290.	4187.	5615.	3427.	4777.	4391.
1000	4133.	5315.	7205.	4319.	6045.	5573.
1100	4984.	6474.	8875.	5235.	7338.	6786.
1200	5843.	7661.	10610.	6175.	8652.	8024.
1300	6708.	8872.	12400.	7140.	9976.	9285.
1400	7578.	10100.	14210.	8129.	11340.	10570.
1500	8450.	11350.	16080.	9141.	12710.	11870.
1600	9326.	12610.	17980.	10180.	14080.	13180.
1700	10210.	13890.	19910.	11230.	15470.	14510.
1800	11090.	15170.	21890.	12310.	16870.	15860.
1900	11970.	16470.	23860.	13400.	18280.	17210.
2000	12860.	17770.	25880.	14510.	19690.	18580.
2100	13740.	19080.	27910.	15640.	21110.	19950.
2200	14630.	20400.	29970.	16780.	22540.	21340.
2300	15520.	21720.	....	17940.	23970.	22730.
2400	16410.	23050.	....	19120.	25410.	24130.
2500	17300.	24380.	....	20300.	26840.	25530.
3000	21780.	31100.	....	26390.	34090.	32620.
3500	26260.	37880.	....	....	....	....
4000	30770.	44710.	....	....	....	....
4500	35280.	51560.	....	....	....	....
5000	39810.	58430.	....	....	....	....

TABLE 11

Mean Heat Capacities of Sulfur Compounds
cal./g-mole · °C.

°C.	S_2	SO_2	SO_3	H_2S	CS_2	COS
0	7.643	9.31	11.60	8.06	10.61	9.39
18	7.686	9.38	11.78	8.09	10.72	9.72
25	7.698	9.41	11.86	8.09	10.77	9.79
100	7.865	9.74	12.61	8.20	11.16	10.18
200	8.030	10.16	13.32	8.37	11.59	10.64
300	8.183	10.52	14.22	8.54	11.94	11.02
400	8.320	10.84	15.02	8.74	12.23	11.34
500	8.342	11.11	15.63	8.96	12.47	11.67
600	8.408	11.35	16.15	9.18	12.67	11.85
700	8.463	11.56	16.61	9.43	12.85	12.07
800	8.509	11.73	17.01	9.59	13.00	12.25
900	8.549	11.87	17.38	9.79	13.13	12.42
1000	8.583	12.00	17.71	9.96	13.25	12.57
1100	8.613	12.12	....	10.12	13.35	12.69
1200	8.648	12.22	....	10.27	13.44	12.81
1300	8.682	12.31	....	10.42	13.52	12.91
1400	8.684	12.40	....	10.55	13.59	13.01
1500	8.702	12.48	....	10.69	13.66	13.11
2000	8.777	12.77	....	....	....	....
2500	8.831	12.96	....	....	....	....
3000	....	13.10	....	....	....	....

TABLE 12

Mean Heat Capacities of Sulfur Compounds
Btu./lb.-mole · °F.

°F.	S_2	SO_2	SO_3	H_2S	CS_2	COS
32	7.643	9.31	11.60	8.06	10.61	9.39
60	7.686	9.38	11.77	8.08	10.73	9.70
77	7.698	9.42	11.86	8.09	10.77	9.79
100	7.735	9.48	11.99	8.12	10.86	9.91
200	7.845	9.72	12.55	8.19	11.15	10.18
300	7.944	9.96	13.07	8.27	11.40	10.44
400	8.030	10.17	13.56	8.36	11.62	10.68
500	8.105	10.38	14.02	8.47	11.81	10.88
600	8.172	10.57	14.44	8.57	11.99	11.08
700	8.229	10.75	14.83	8.68	12.16	11.27
800	8.280	10.92	15.19	8.80	12.30	11.44
900	8.326	11.07	15.53	8.91	12.43	11.58
1000	8.367	11.20	15.84	9.02	12.56	11.72
1100	8.403	11.32	16.12	9.14	12.67	11.85
1200	8.434	11.45	16.38	9.27	12.77	11.98
1300	8.463	11.56	16.63	9.37	12.86	12.09
1400	8.490	11.66	16.86	9.48	12.95	12.19
1500	8.514	11.75	17.08	9.59	13.03	12.29
1600	8.536	11.83	17.28	9.69	13.10	12.38
1700	8.556	11.91	17.47	9.80	13.17	12.47
1800	8.575	11.98	17.65	9.89	13.23	12.55
1900	8.593	12.05	....	9.99	13.29	12.62
2000	8.610	12.12	....	10.09	13.35	12.69
2100	8.625	12.18	....	10.18	13.40	12.75
2200	8.639	12.23	....	10.25	13.45	12.81
2500	8.677	12.38	....	10.48	13.58	12.99
3000	8.720	12.58	....	....	....	....
3500	8.766	12.74	....	....	....	....
4000	8.798	12.86	....	....	....	....
4500	8.838	12.96	....	....	....	....
5000	8.853	13.04	....	....	....	....

publication. There are no calorimetric values for sulfur trioxide heat capacity.

Of this entire group of compounds only hydrogen sulfide has been the subject of recent calorimentric work, Felsing and Drake.[7] The recommended spectroscopic data are those of Cross.[5] These data will very possibly be improved as Cross stated that the vibrational spectrum had *not* been sufficiently studied to enable an exact determination of the vibrational constants. The results were obtained by making an intelligent selection of these. Although Justi[12] used the same data as Cross, there exists an appreciable difference in the two sets of data at the lower temperatures. After checking Cross' data by reproducing his calculations, the data of Cross were used in this paper. The value at 25° C. in the *Selected Values of Chemical Thermodynamic Properties*[28] agrees with that from Cross and not Justi.

The calorimetric data for carbon disulfide are without exception very old. The only spectroscopic work, that of Cross,[6] are recommended. There are no data on carbon oxysulfide except those of Cross.[6] The heat capacities of carbon disulfide and carbon oxysulfide at 0 and 18° C. were calculated by the statistical equations of Cross.

A resume of the heat capacity work on these compounds is made in Table 1. The standard heats and free energies of formation from the most reliable sources are given by Table 2.

Tables 3, 4, 5 and 6 are even temperature increment tabulations of the instantaneous molal heat capacities on each of the four temperature scales. These data are plotted on the Centigrade and Fahrenheit scales in Figure 1.

The ice-point relative enthalpies are listed in Tables 7, 8, 9 and 10. As in the previous cases[16, 17, 18, 19, 20, 21, 22] these were obtained by careful integration of the actual heat capacity-temperature relations (Tables 3, 4, 5 and 6) and *not* by an integration of an approximation equation. Figure 2 is a convenient double logarithmic plot of the enthalpy-temperature relation.

The mean molal heat capacities, Tables 11 and 12, are reported on only the Centigrade and Fahrenheit temperature scales. These values are equivalent to the enthalpy data of Tables 7 and 9, respectively.

Equations empirically derived to fit the data given in

this article are given in Table 13. The maximum error involved in the use of these equations up to 1500° C. never exceed one percent.

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TABLE 13
Heat Capacity Equations of Sulfur Compounds
$C_p^\circ = a + b(t) + c(t^2) + d(t^3)$
cal./g-mole · °C. or °K.
Btu./lb.-mole · °F. or °R.

		a	b · 10³	c · 10⁶	d · 10¹⁰	Percent Error Max.	Percent Error Avge.	Temp. Range °C.
S_2:	°C.	7.675	3.388	— 3.108	9.520	0.99	0.38	0—1500
	°K.	6.499	5.398	— 3.888	9.530			
	°F.	7.815	1.943	0.9748	1.832			
	°R.	6.499	2.943	1.200	1.832			
SO_2:	°C.	9.299	9.350	— 7.418	20.57	0.45	0.24	0—1500
	°K.	6.157	13.94	— 9.103	20.57			
	°F.	9.134	5.328	— 2.323	3.327			
	°R.	6.157	7.849	— 2.810	3.327			
SO_3:	°C.	11.891	21.96	—20.41	77.44			
	°K.	3.919	34.83	— 26.75	77.44	0.99	0.13	0—1000
	°F.	10.964	12.51	— 6.322	13.28			
	°R.	3.919	19.35	— 8.256	13.28			
H_2S:	°C.	8.010	3.097	+ 0.7200	— 7.867	0.74	0.37	0—1500
	°K.	7.070	3.128	+ 1.364	— 7.867			
	°F.	7.946	2.040	+ 0.2245	— 1.340			
	°R.	7.070	1.738	+ 0.4210	— 1.340			
CS_2:	°C.	10.094	9.510	— 8.704	27.60	0.76	0.47	0—1800
	°K.	7.390	14.89	—10.96	27.60			
	°F.	10.558	5.460	— 2.730	4.733			
	°R.	7.390	8.272	— 3.383	4.733			
COS:	°C.	9.980	10.16	— 8.480	25.60	0.94	0.49	0—1500
	°K.	6.222	18.30	—10.58	25.60			
	°F.	9.400	5.866	— 2.650	4.390			
	°R.	6.222	8.533	— 3.266	4.390			

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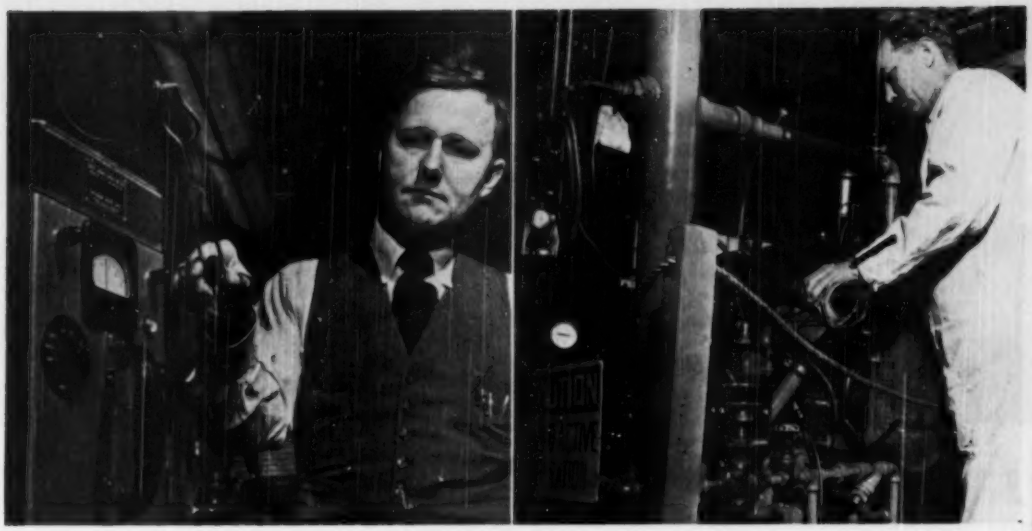
* * *

California Standard's Richmond Plant Gets Safety Award

REFINERY employes at Standard Oil Company of California's Richmond plant chalked up one of the best safety records in the history of American oil refining on December 4 when they registered 2 million consecutive man hours of work without a lost-time accident.

This record was accomplished over a four-month period of around-the-clock operation by the refinery's 3600 workers, and makes Richmond the third refinery in the history of the industry to reach this safety mark.

Left to right in the accompanying photo are: R. E. Donovan, manager, safety division; G. R. Kilborn, safety engineer, Richmond refinery; O. N. Miller, general manager, manufacturing department; R. K. Rowell, general manager, Richmond refinery; T. E. Flowers, refinery safety engineer, Richmond refinery; T. S. Petersen, president, Standard Oil Company of California; F. D. Longworthy, safety engineer, Richmond refinery and G. A. Davidson, vice president, Standard Oil Company of California.



Top left—California Research Corporation engineer tests radioactivity of piston ring, which has previously been exposed to atomic pile, before placing it in test automotive engine. Top right—Operator returns sample of lubricating oil to crankcase of test engine after amount of radioactive iron present has been determined by means of a Geiger counter (see picture below). The fountain-pen device attached to sleeve is a radiation meter which measures amount of radioactivity to which he has been subjected while working around the equipment.

Nuclear Fission Used to Improve Oil Processes

APPLICATION of war-born nuclear fission to speed up improvement of automotive fuels and lubricants, announced in PETROLEUM REFINER February, 1949, page 172, has caused much comment in the industry.

California Research Corporation, Standard Oil Company of California's research organization, at its Richmond, Calif., laboratories is using the revolutionary research method some of the phases of which are pictured herewith.

Radioactive carbon, for instance, is being used to learn more about what happens to gasoline molecules as they pass through the complex operation of a modern refinery. The chemist labels a gasoline molecule by substituting a radiocarbon atom for an ordinary carbon atom. The exact fate of the hydrocarbon molecule can then be studied by means of a Geiger counter. "It is expected" the the researchists said, "that this new scientific tool will contribute to the steady improvement in methods of producing better petroleum fuels."

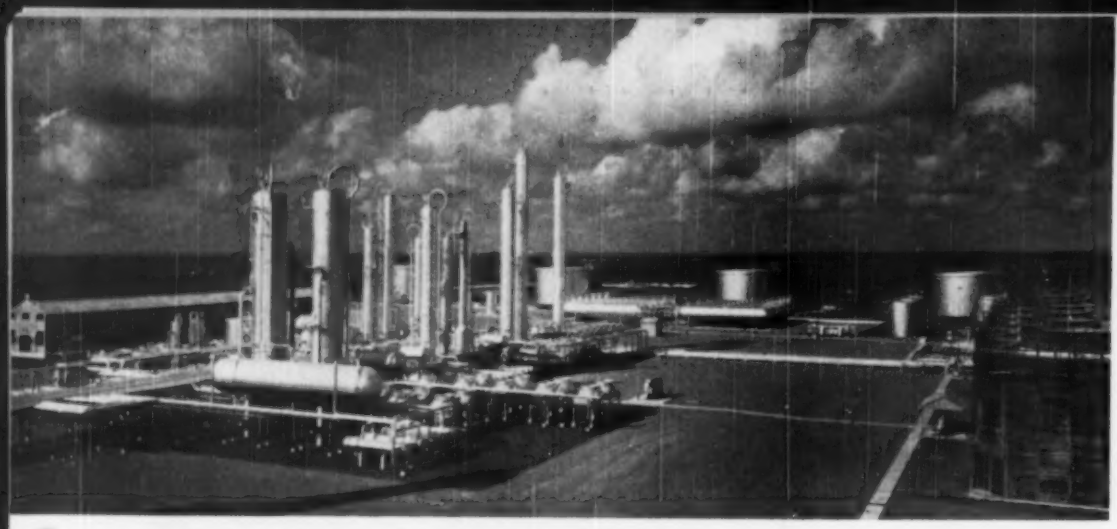
Another project involves the use of radioactive automotive parts to test engines. This method has enabled engineers to run fuel and lubricants in a much shorter time than heretofore prevailed and, it is hoped, will result in longer engine life and less money spent by motorists for repairs, as well as more economical automobile operation.

For this test, a radioactive piston ring is placed on the test engine's piston. After three or four hours of operation, a sample of oil, taken from the engine's crankcase, tested with a Geiger counter which indicates the amount of metal worn from the activated ring—minute particles of iron flushed away by the oil. Thus the amount of wear can be measured closely, as little as one-millionth of an ounce of metal worn from the rings being detected.

Another oil industry use of radioactive substances involves the tracing of oil shipments through pipe lines. This is accomplished by placing one-billionth of an ounce of radioactive barium in an oil sample, and then following the sample's progress with a Geiger counter. In this way it becomes possible to separate more accurately the many types of crude oil or products which flow one behind the other through a given line.

It was explained that "the radioisotope is added in such minute quantity and its half-life is so short that it completely disappears during the refining operation." In other words, no radioactivity would be present in oil products sold to consumers.

Research engineer runs Geiger counter test immediately after run to determine amount of metal worn from radioactive piston ring used in automotive engine during 4-hour operation.

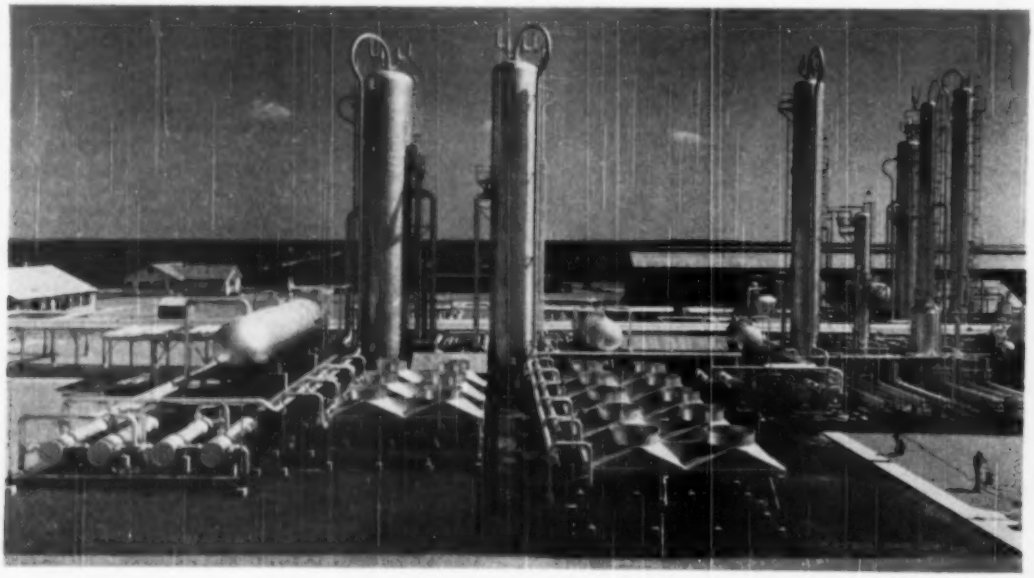


Above—The Burnell-North Pettus Cycling Plant, Five Miles Northeast of Pettus, Bee County, Texas. Stanolind Oil and Gas Company operates the plant for the group of owners. Compressor building is at far left with process area in foreground, product storage area in background and water cooling tower at extreme right.

New Texas Cycling Plant Operated by Stanolind

THE Burnell-North Pettus cycling plant, recently placed on steam by Stanolind Oil and Gas Company, was designed to process 166 million cubic feet daily of natural gas for the extraction of more than 330,000 gallons daily of liquid products. Approximately one-half the liquid production is natural gasoline. Location of the plant is near Pettus, Bee County, Texas. Owners of the plant, operated by Stanolind, include: Stanolind, Magnolia Petroleum Company,

Process Area of New Cycling Plant Showing Aerial Type Coolers in Foreground. Primary and secondary stills are in center of picture. Towers at right are (foreground, left to right) naphtha column and side cut stripper, distillate stabilizer, (background), casinghead absorber, propanizing absorber.



Anderson-Prichard Oil Corporation, Continental Oil Company, Rock Hill Oil Company, Sun Oil Company, Tom Slick, Gas Properties, Inc.; E. G. Bradley, Atlantic Refining Company, Jane Blumberg, Stewart Petroleum Company, George R. Brown, Tide Water Associated Oil Company, Phillips Petroleum Company, A. B. Bauchman, Highland Oil Company, Russ Oil Corporation, Maracaibo Oil Exploration Corporation, Marquis Eaton (trustee for A. R. Bauchman, E. G. Bradley, H. N. Mallon, J. B. O'Connor, E. A. Tapp, Tuesday Oil Company, and H. H. Weinert).

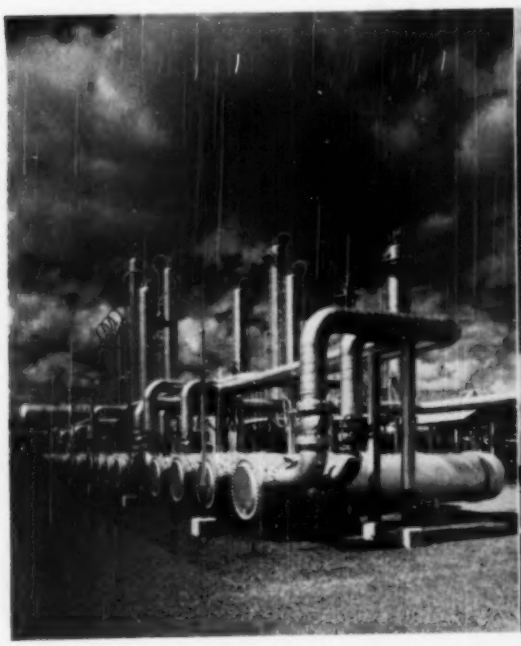
Dry gas from the plant is injected into the producing formations through seven injection wells, three in the Burnell field and four in the North Petus field. The gas is compressed to 3400-pounds pressure for injection by the compressor installation, which includes two 600-horsepower units and five 1600-horsepower units. The small compressors are used for compressing casinghead gas for processing, while the larger units are used for recycle and booster compression. In addition to injection, the plant also sells an estimated 30 million cubic feet daily of residue gas for use as fuel in nearby cities.

Absorbers of the plant are operated at 1600, 800, and 200-pounds pressure. The process design makes use of primary and secondary stills in the stripping operations. Steam for the plant is generated in two gas-fired boilers, each capable of generating 90,000 pounds per hour, and either capable of supplying the plant's requirements of 81,000 pounds per hour. Steam is used in processing and for turbine-driven generators and pumps. Three direct-fired heaters are used for rich oil heating, and other heat requirements. Electric power for the plant and camp is generated by two 1500-kw. generators. Three water wells of 250-gallons-per-minute capacity supply water, which is treated for domestic and plant use.

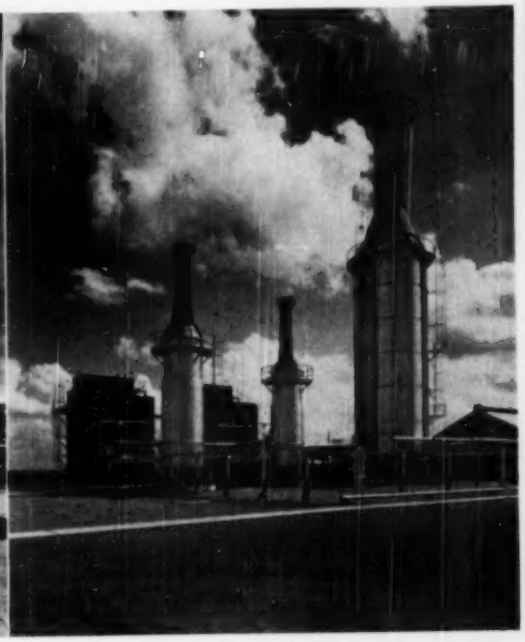
The plant is under the supervision of A. C. Andrews. Other members of the staff include H. K. Boswell, plant foreman; C. B. Barker, plant engineer; C. W. Monday, plant chemist, and O. B. Rowley, maintenance foreman.

Aerial View of Burnell-North Pettus Cycling Plant.

Power Plant Area Showing Direct-Fired Heaters and Steam Boilers. Generator building is at extreme right.



Row of Lean Oil-to-Rich Oil Heat Exchangers at Cycling Plant. Process area is in background.



Ultimate Yield Nomograph For Recycle Processes

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FOR various chemical and economic reasons, many processes are not reacted to completion; thus a certain percentage yield is obtained per pass or cycle. The unreacted material is recovered and all or part of the recovered material is reprocessed with fresh stock. The recovered material that is reprocessed is usually designated as cycle stock. Under definite and controlled conditions the percentage yield and the amount of cycle stock charged per pass can be held fairly uniform.

To determine the most effective or economical relation between the yield of product and the cycle stock per pass, the ultimate or equilibrium yield must be known. This value can readily be determined by the following mathematical relationship based on the assumption that 1) a unit amount of fresh material is charged for the first pass with only the resulting cycle stock charged in the succeeding passes, and 2) that the fractional yield from the cycle stock is the same as that from the fresh stock.

Let x = fractional yield of product per pass

y = fractional amount of cycle stock per pass

S = fractional ultimate yield of product

Pass No.	Product, Fraction	Cycle Stock, Fraction
1	x	y
2	xy	y^2
3	xy^2	y^3
4	xy^3	y^4
n	xy^{n-1}	y^n

$$S = x + xy + xy^2 + xy^3 + \ldots xy^{n-2} + xy^{n-1} \quad (1)$$

Multiplying by y,

$$yS = xy + xy^2 + xy^3 + \ldots xy^{n-2} + xy^{n-1} + xy^n \quad (2)$$

Subtracting Equation 1 from Equation 2,

$$yS - S = -x + xy^n \quad (3)$$

$$S(y-1) = x(y^n - 1)$$

$$S = \frac{x(y^n-1)}{y-1} = \frac{x(1-y^n)}{1-y} \quad (4)$$

Equilibrium conditions occur when n becomes infinite. Since y is less than 1,

$y^n = 0$ for $n = \infty$

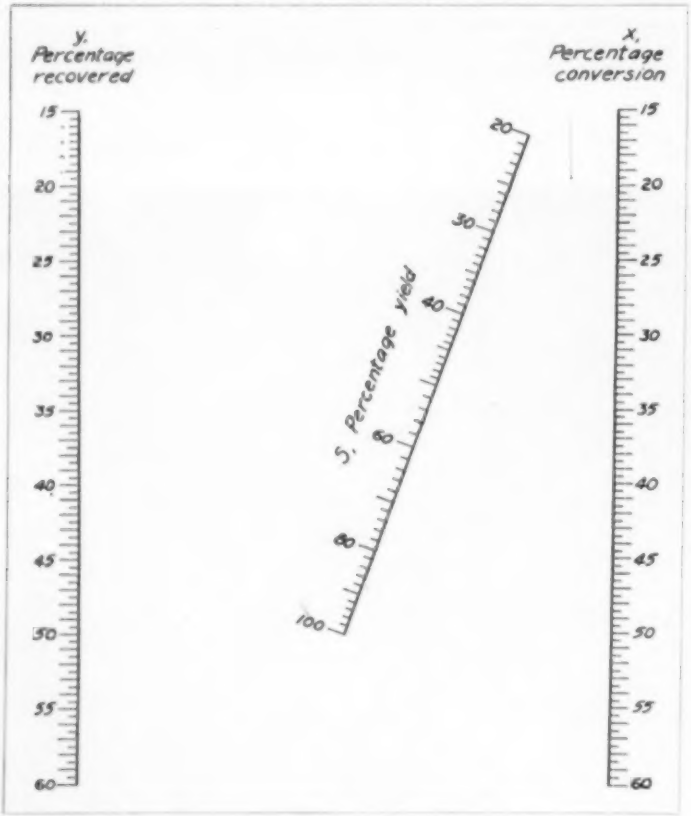
Then, $$S = \frac{x}{1-y} \quad (5)$$

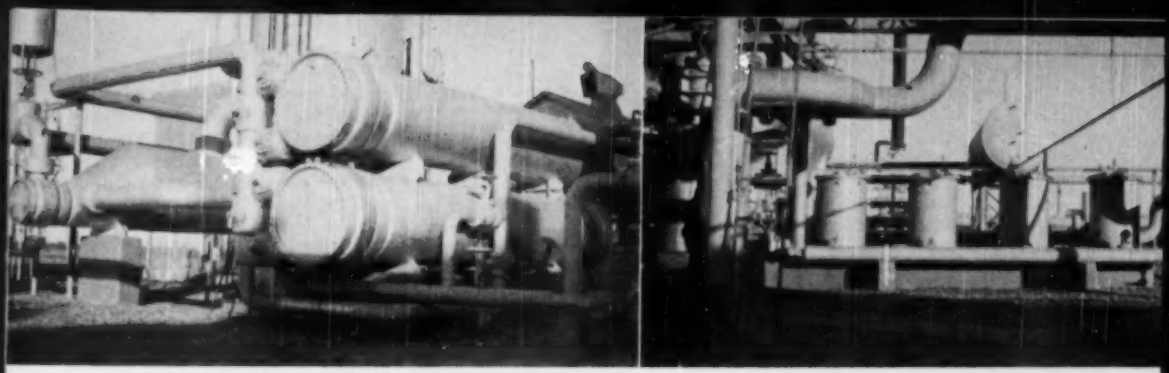
Example: Ethane, catalytically cracked at 1510° F., with a contact time of 2.4 seconds, resulted in a reaction mixture which yielded 48.3 percent of ethylene and 22.8 percent of ethane, based on the weight of the charge. What is the ultimate yield of ethylene when the total amount of ethane recovered from the reaction mixture is used as cycle stock?

$$S = \frac{0.483}{1.000 - 0.228}(100) = 62.6 \text{ percent},$$

which is the ultimate yield of ethylene that is obtainable by using the total amount of ethane recovered from the reaction mixture as cycle stock.

The accompanying nomograph simplifies and expedites calculations for wide ranges of percentage yield of product per pass and various charges of cycle stock.





Above, left—Exchangers and Reboiler in DEA Plant of Skelly Oil Company at Eunice, N. M. Right—Filters for DEA Stream in Skelly's Plant.

Skelly Removes H_2S From Sour Gas at Eunice

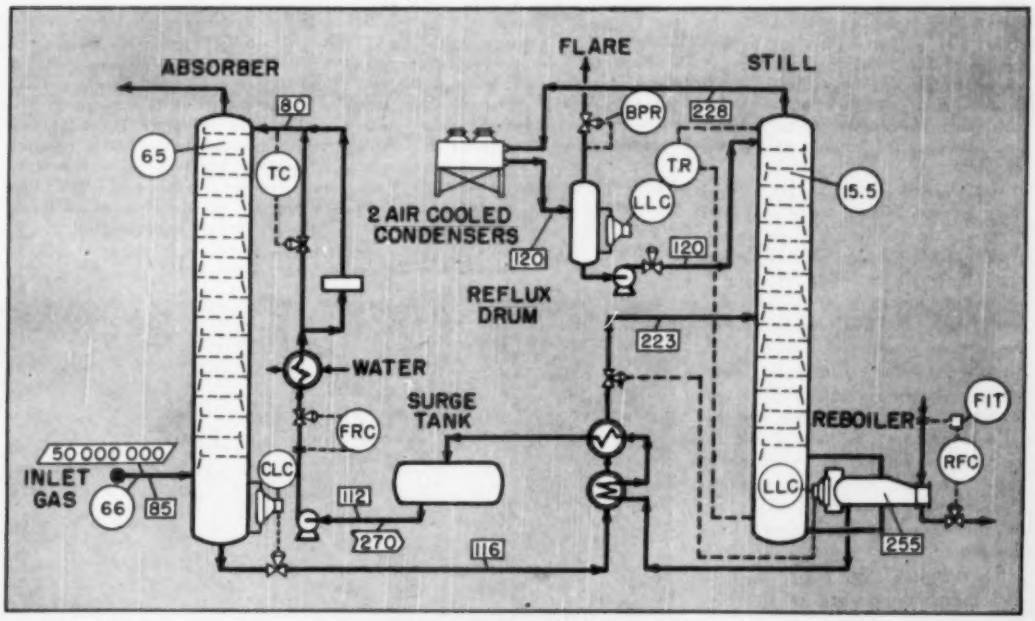
SKELLY Oil Company recently completed construction of additional facilities in its absorption natural gasoline plant, in the Eunice field of New Mexico, to extract and remove hydrogen sulfide from the casinghead gas processed in the plant. The average hydrogen sulfide contamination is in the order of 600 grains for each 100 cubic feet of natural gas. Carbon dioxide present in the gas—averaging about 6 percent of the total volume handled daily. The plant is operating with a load of 64 million cubic feet daily. As a result of H_2S removal, routine tests indicate "doctor" sweet products.

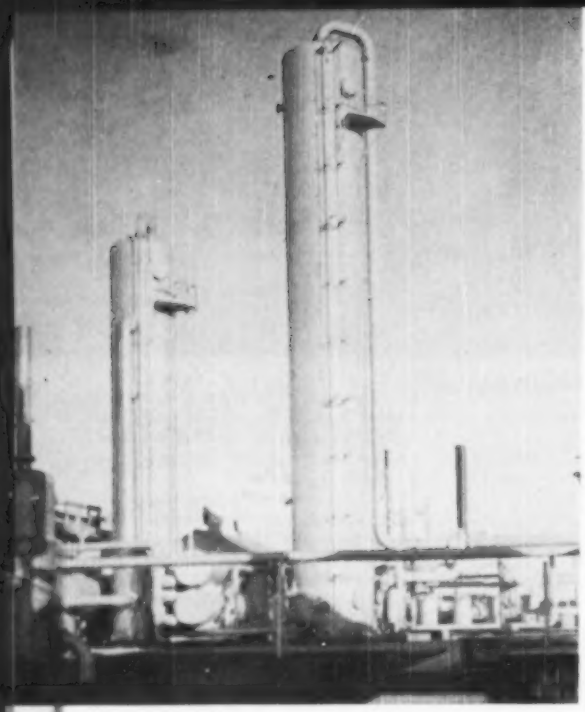
The gas-sweetening unit makes use of diethanolamine to extract the acid gases from the rich casinghead gas, before product fractionation so that both the liquefied petroleum products and the residue gas are free of hydrogen sulfide.

The casinghead gas gathered from the wells in the area is handled by a large compressor installation at an intake pressure of 11 psig. and discharge pressure of 65 psig. The gas is

TEMPERATURE, pressure, and flow data for this hydrogen sulfide removal unit indicate the typical operation of such plants using monoethanol amine solutions for acid gas absorption.

Figure 1. Flow Diagram of Hydrogen Sulfide Removal Process





Columns in Skelly's Eunice DEA Extraction Plant.

cooled to an average temperature of 80° F. in radiator type coolers followed by further cooling in an atmospheric cooling tower. Gas flows to the plant through a 20-inch pipe line.

In the DEA absorption column the acid gases are extracted from the raw gas by contact with diethanolamine. The absorber is 10 feet in diameter and 67 feet high. From the DEA absorber the gas flows to the absorption section of the gasoline plant for extraction of natural gasoline, which requires no treatment except washing with caustic to remove mercaptan sulfur to prepare it for fractionation and shipment.

Motor driven centrifugal pumps take suction from a large surge tank and discharge the rectified DEA to the top of the absorber at a rate of 270 gallons per minute, or at a rate of about 6 gallons of solution for each 1000 cubic feet of sour gas. Entering the absorber, the solution flows down over the bubble plates so that an intimate contact can be obtained between the DEA and the sour gas flowing upwards. The rich DEA flows from the base of the absorber at 65 psig. It enters a bank of two horizontal shell and tube exchangers where it is heated by the lean solution from the rectifier, or DEA distillation column.

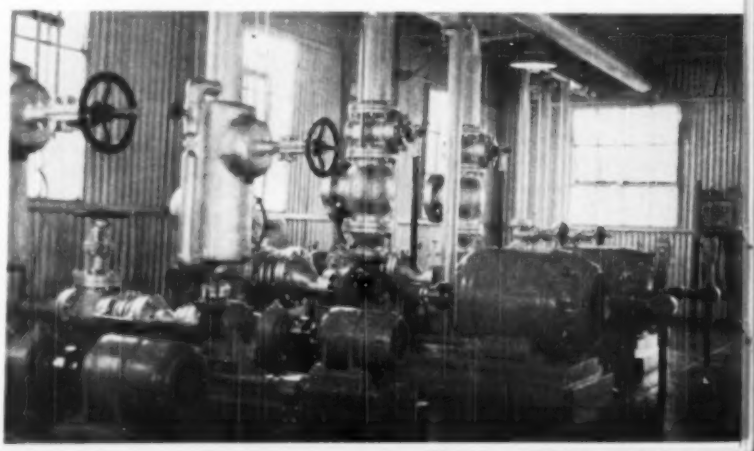
The solution then enters the still and travels downward to the base through a steam heated reboiler to maintain a processing temperature of 228° F. The acid gases are stripped from the DEA solution and flow overhead from the still through air coolers and water serviced after-coolers to condense water vapor which might be carrying diethanolamine from the overhead outlet of the still. The product of the overhead stream is accumulated in a receiver from which the acid gas flows to a flare some distance from the gasoline plant and burned. The liquid product of the overhead stream is picked up by reflux pumps, which return the solution to the rectifier for top temperature control, and to control the strength of the DEA solution, maintained at a strength of 19.3 for optimum results.

The lean solution flows from the still at 18 psig., through the bank of exchangers, back to the surge tank from which the pumps take suction on the solution at a temperature of 112° F. From the pumps the solution flows through coolers, which lower the temperature to 80° F. Provision has been made in the circulation system to prevent the temperature of the DEA from falling to an undesirable low degree by using temperature controlling instruments, which operate bypasses around the solution coolers. This method maintains the temperature of the solution entering the absorber at the point which is desired.

Steam to maintain the required temperature in the rectifier on the distillation unit is produced with three package-type boilers, which have a steam generating capacity, without heavy firing, of 18,000 pounds per hour at 200 psig. These boilers and the reboiler unit are operated as closed units, because the hot well, into which steam and condensate flow from the reboiler, is a pressure vessel operated at 175 psig., and the contents have a temperature average of 300° F. With tight fittings and gaskets, no appreciable loss of water is encountered, except that from normal blow-down of gage glasses and boilers. Water to supply these boilers amount to about 400 gallons per day. Clean, uncontaminated condensed steam from other portions of the gasoline plant is obtained for boiler feed make-up and is accumulated in a horizontal vessel near the boilers. The greater portion of this water is for make-up to supply normal loss through steaming; however it is used by the fireman to fill a cold boiler after a shutdown and cleanout by gravity flow from the surge tank because the head on the tank is sufficient for this purpose.

The results arising from the operation of this hydrogen sulfide unit are readily apparent: The absorption and distillation sections of the gasoline plant are free from corrosion and accumulation of iron sulfide, many times the cause of column failure. Liquefied petroleum fractions from natural gasoline to LPG are produced without the hard-to-extract sulfur compounds, and treating costs fall in comparison with the extraction of acid gases. The residue gas is ready for pipe line transmission anywhere fuel is required without further treating, and combustion cylinders, valves and spark plugs of engines remain in good condition without frequent overhauling.

Pump Room of Skelly's DEA Plant at Eunice, N. M.



Alignment Chart for Calculating Relative Volatility

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Potsdam, N. Y.

***THE GREAT PROGRESS** that has been made in recent years by the petroleum industry in the fractional distillation with sharp separation of hydrocarbons has created a demand for rapid design calculation methods. One factor in design is the difficulty of separation which is indicated by the relative volatility of the components of the feed stream. Where complete vapor pressure data are at hand the relative volatility is calculated as the ratio of the vapor pressures of the two key components. Frequently, however, complete and reliable vapor pressure data are not available so that a general need for determining relative volatility from physical constants.*

A METHOD[1] has been developed for calculating the relative volatility of binary mixtures from boiling point difference, absolute boiling point of the mixture, and total pressure, in the form of the equation:

$$\text{Log } \alpha = \frac{\Delta T}{T} \left(7.30 - 1.15 \text{ Log P} + \frac{T}{179 \text{ Log P}} \right)$$

Where P is the absolute pressure in mm of mercury at which T and ΔT are measured. T is the average boiling point of the mixture in degrees Kelvin. ΔT is the difference in boiling points of the two components in Centigrade degrees.

This cumbersome formula can be quickly and accurately solved by nomograph. The chart scales have been extended to include temperatures in Fahrenheit degrees and pressure in pounds per square inch absolute (psia.). In the example shown on the chart it is desired to calculate the relative volatility of the two key components of a mixture having the composition:

Propane	0.50 mol percent
Isobutane	24.5
N-butane	73.5
Isopentane	1.5

Cooling water and heating steam conditions require that a pressure of 100 psig. be used. Assuming the mixture to be a binary mixture of n-butane and isobutane, we have the physical properties at 100 psig.:

Isobutane boiling point	132° F.
N-butane boiling point	155° F.
Average boiling point of mixture	146° F.

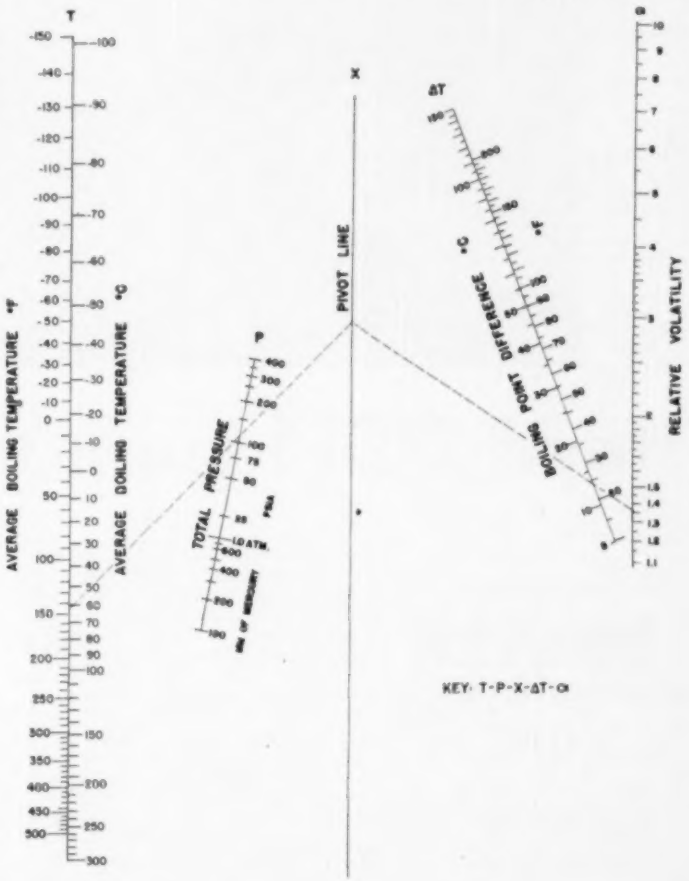
On the chart enter at 146° F. average boiling point and draw a straight line through 114.7 psia. to intersection with the pivot line, X. Connect this intersection with the boiling point difference (23° F.) and continue to the relative volatility scale (1.36).

As a check on this, calculate the relative volatility from vapor pressures:

Isobutane vapor pressure at average boiling point	134
N-butane vapor pressure at average boiling point	99

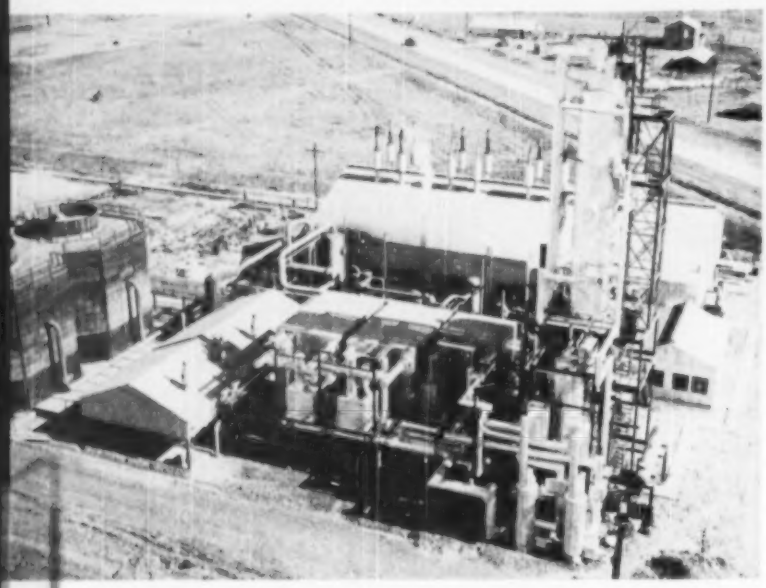
The ratio of vapor pressures, 134/99 is 1.355.

The method is applicable only to mixtures such as the paraffin hydrocarbons in which there is no appreciable deviation from Raoult's law. Values of relative volatility above 10 are unreliable when calculated by the formula.



REFERENCES

[1] Melpolder, F. W., and Headington, C. E., Ind. & Eng. Chem., 39, 763 (1947).



Ninety-five Percent Purity Oxygen Plant Built for McCarthy Chemical Company at Winnie, Texas. This plant produces 175 tons of oxygen per day.

Oxygen Plant Design Standardized

A STANDARD ten-ton-per-day oxygen plant, capable of producing at 95 percent purity oxygen, using normal atmospheric clean air as raw material, has been announced by Stacey Dresser Engineering Company, Cleveland, Ohio, a division of Stacey Brothers Gas Construction Company.

This small, standardized unit is similar in general details of construction and operation to the design worked out for a larger plant, the 175-ton-per-day capacity oxygen unit recently built for McCarthy Chemical Company at Winnie, Texas.

The plant is compact and can be accommodated on 32 by 24 feet floor space. It has prefabricated piping and only five pieces of equipment outside the cold box. The cold box is 13x8x32 feet, enclosing three quarters of the fractionating tower and all exchangers and cold piping.

An economy feature claimed is low-pressure operation, with only water and low-pressure steam and electricity needed. Net weight, including equipment, insulation, cold box (complete except foundations and shelter for equipment outside cold box) is 80,000 pounds. Principal data are:

Plant Production

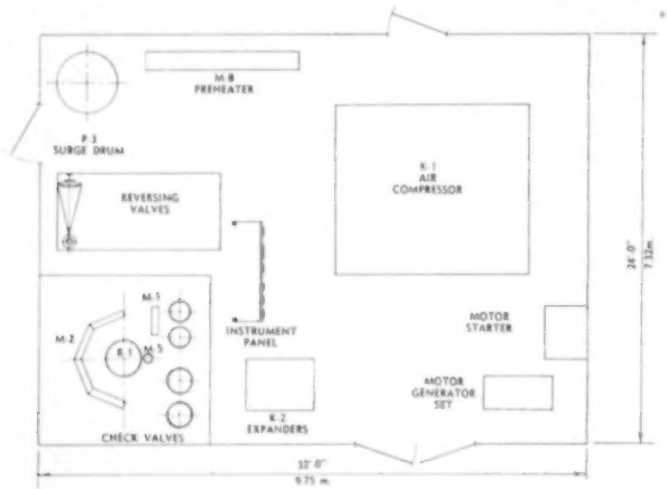
10 net short tons of oxygen per day
95 percent purity oxygen
10.5 gross short tons of product

Product

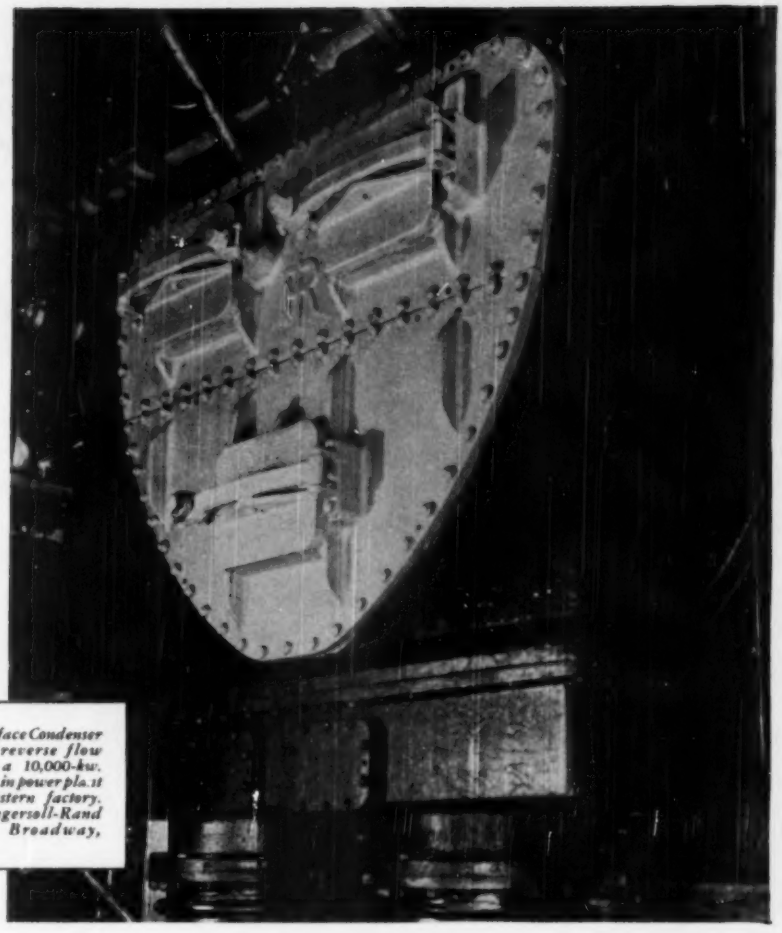
Analysis on a carbon dioxide free and dry basis:
Oxygen, 95.0 percent by volume
Argon, 2.3 percent by volume
Nitrogen, 2.7 percent by volume
Carbon dioxide and water vapor will be present in the same concentration as in the air charged to the reversing exchangers (approximately 0.03 percent carbon dioxide and 0.6 percent water vapor).
Discharge pressure of product, 1.5 psig. (0.1 kg/cm²)
Temperature of product, 71.5° F. (22° C.)

Utilities required

Low pressure saturated steam, 10 lbs./hr. (4.5 kg/hr.)
Steam condensate, or equal, 3-4 gph. (12-15 liter/hr.)
Cooling Water (70° F., 20-40 psig.), 80 gpm. (300 liter/min.)
Electricity for power (380-440 volt), 181 kw.
Electricity for lighting and instruments (110 Volt), 2 kw.



Plot Plan of the 10-Ton-per-Day Oxygen Plant, with Production 95 Percent Purity.



A Two-Pass Surface Condenser with built-in reverse flow valve, serving a 10,000-kw. turbo-generator in power plant of a large Eastern factory. Photo from Ingersoll-Rand Company, 11 Broadway, New York.

This heart must NOT beat!

● This heart-shaped condenser must stand solid as a rock, silent and unmoving, if its tubes are to serve out their appointed time. Yet it is sometimes true that changed conditions, or the operation of other machinery, will produce damaging vibration in a condenser, no matter how perfectly it was originally designed, built and installed. The good old test of the palm of your hand against the condenser shell is not adequate; tiny unfelt quivers may be shortening tube life. Vibration accelerates corrosion in several ways. The alternating stresses in time produce cracks across the grain of the metal, weakening it and giving corrosive elements new points to attack. Vibration may also disrupt or disturb the thin film on the surface of the metal that protects it and helps reduce the rate of corrosive attack. Of course vibration is but one of a number of factors affecting the service life of condenser tubes, and so when tube life becomes short we always suggest that samples from failed tubes be sent to us. If vibration is a factor, microscopic examination will show it. Other influences will be sought, and in the end we may be able to make suggestions that should materially extend the time between re-tubings, restoring the condenser to the original efficiency. Why not use our know-how as well as our tubes and tube plates?

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REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

SolventExtractionData Article Prepared By Magnolia Engineers

TWO Magnolia Petroleum Company engineers at the Beaumont, Texas, refinery prepared the article beginning on page 89, "Temperature Gradient in Solvent Extraction of Lubricating Oils." E. J. Reeves is supervisory process engineer of the lubricating oil and wax section of the process control laboratories, and E. P. Hardin is process engineer in the laboratory.

Editorial Experience

Reeves graduated from Rice Institute as a chemical engineer and joined Magnolia as process engineer in 1943. Since that time his experience has included waxes and lubricants, Houdry catalytic cracking units, and the process control laboratories in the lubricating oil and wax section.

He is an active member of ACS, petroleum division, and has served on the staff of *The Condenser*, publication of the Texas-Louisiana Gulf Section of ACS. Reeves is an abstractor for *Chemical Abstracts*. He and Mrs. Reeves are proud parents of a little miss, now nearing her second birthday.

The present article is Reeves' third presentation in **PR**. He has previously published "Optimum Dilution in Viscous Liquid Filtration," *Industrial and Engineering Chemistry*; "Rotation Speed in Continuous Filter, **PR**; "Effects of Solvent Composition and Primary Solvent Dilution on Dewaxing Filter Rates and Wax Oil Contents," **PR**, and Optimum Temperature Gradient in Selective Solvent Extraction," *Industrial and Engineering Chemistry*.

Texas A. & M. Grad

E. P. Hardin, co-author of the article in this issue of **PR** with Reeves, is a graduate of A&M College of Texas, 1947. He received his bachelor of science degree in chemical engineering.

Hardin was born in 1922 in St. Louis, where he attended grade and high school. He entered A&M in 1941, but interrupted his studies to enlist in the Army in 1943. After a year with the infantry in Europe, he returned to Aggieland in January, 1946, obtaining his degree a year later.

In 1947, Hardin came to Magnolia as a junior process engineer. He transferred to the process control laboratories in 1949, where he is doing experimental work on lubricating oils and waxes. He is not married.

"Temperature Gradient in Solvent Extraction of Lubricating Oils" is a sound discussion and our readers will find it of considerable value.

E. P. HARDIN

E. J. REEVES

Cylindrical Furnaces is Topic Of Sinclair's Combustion Engineer

O. F. CAMPBELL, whose article, "Cylindrical Furnaces for the Petroleum Industry," starts on page 109 in this first 1950 issue of PR, is a confirmed believer in the cylindrical furnace. In an issue of PR last summer, Campbell read an article wherein the efficiency of a cylindrical furnace was low-rated from 76.8 percent to between 60 and 65 percent. Feeling that "just consideration" had not been given the furnaces in question, Campbell submitted his article, which he also presented before the ASME semi-annual meeting in San Francisco, for publication. Like the true engineer, Campbell has set down his discussion in easily understood sentences, fully describing his subject.

Not Even Photography

Campbell is a graduate of the University of Michigan (1922) in chemical engineering. He went to work for Sinclair Refining Company and has been with them since his graduation from Michigan. His job is combustion engineer.

He is a member of the American Legion, ASME, and API.

Say Campbell did have some special hobbies, which he denies categorically, it likely isn't photography, because in reply to a telegram reminding him that his likeness was needed for this page, he stated "no personal photograph on hand."

His knowledge of philately, photography period furniture or even little theater work might be limited, but when it comes to furnaces, a reader of his current article will soon become convinced that he is no novice.

Metallurgist's Hobby Is Antique Furniture

F. G. SEFING, of International Nickel Company, reconditions antique furniture and collects and studies classical music as relaxing hobbies from his current work in promoting corrosion-resisting, nickel alloyed cast irons. The title of Sefing's article is "The Basis for Selecting Alloy Cast Irons for the Petroleum Industry," and begins on page 97 of PR.

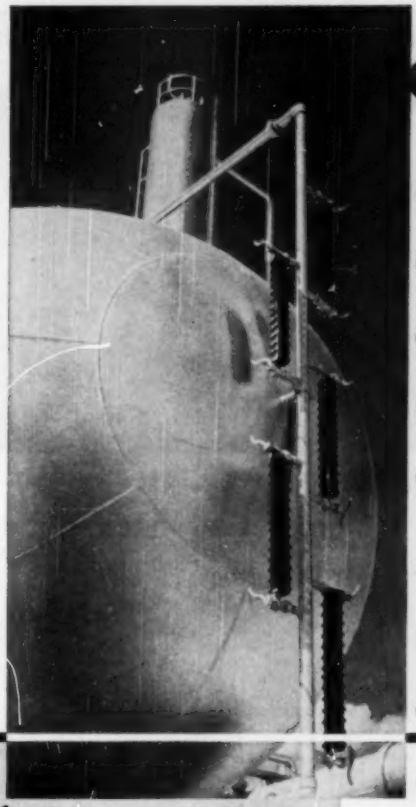
He is a graduate of Lehigh University

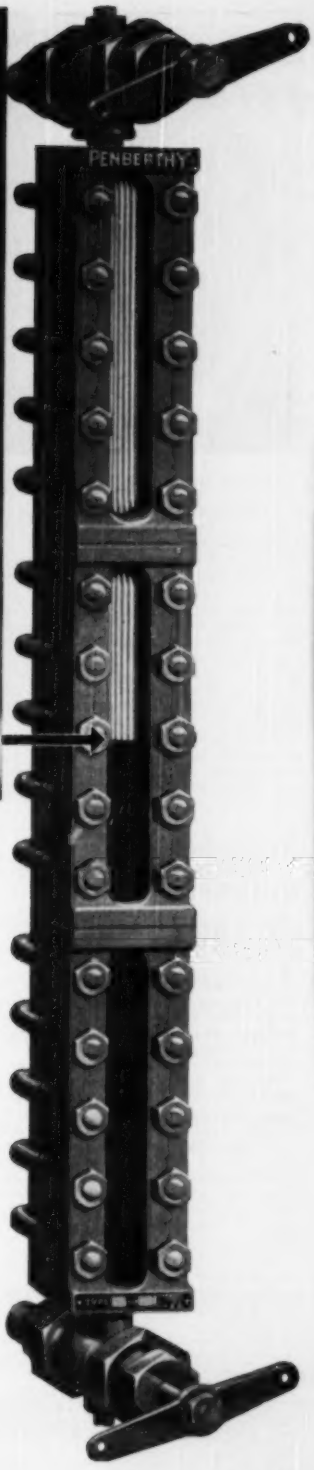
WHEN YOU MUST

BE SURE

OF THE

LIQUID LEVEL





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Penberthy Drop Forged Steel Reflex Gages are available in whatever lengths required and for various liquids; they meet API—ASME requirements and are recommended for pressures up to 3000 psi at 100° F and 1000 psi at 1000° F.

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2366

F. G. SEFING | GEORGE ROBERTS, JR. | P. R. SCHULTZ | WILLIAM C. FRISCHE

in Metallurgical engineering and obtained his M.S. from Penn State. Sefing joined INCO in 1937 after spending the preceding 15 years teaching metallurgy at Penn State and Michigan State, and engaging in consulting work on steels and cast irons in Michigan. Since then he has worked on the development of alloyed cast irons, both in foundries and among castings users.

Sefing is a national director of the American Foundrymen's Society, and a trustee of the Foundry Educational Foundation.

While he admits that the point is not necessarily unique, Sefing claims to be a connisseur of good eating and drinking, which as hobbies can be one's undoing.

Stanolind Men Do Interesting Article On Liquid Fuels

TWO men from Stanolind Oil and Gas Company, Paul R. Schultz, manager of the economics department, and George Roberts, Jr., present the article beginning on page 104, "Liquid Fuels from Coaland Oil Shale."

Paul R. Schultz joined Stanolind in 1936 as chief chemical engineer. Previously he was employed by Standard Oil Company (Indiana). He is a graduate of Armour Institute in Chicago and the Case School of Applied Science, where he received a degree in chemical engineering. Schultz is a member of American Institute of Mining and Metallurgical Engineers and the American Chemical Society.

George Roberts, Jr., was employed by Stanolind in 1943. For 10 years prior to that time he had been with The M. W. Kellogg Company in New York. Graduating in 1932 from the University of Kentucky with a bachelor of science degree in industrial chemistry, Roberts did graduate work at the University of Michigan in chemincal engineering. He is a member of the American Chemical Society, the American Institute of Chemical Engineers, and the American Petroleum Institute.

Kentuckian Rates Home Movies Hobby

JUST intimate that you don't mind and William C. Frische, who contributed the "Alignment Chart for Calculating Relative Volatility," page 137, will be pleased to exhibit the fruits of his efforts as an amateur movie photographer. Needless to say, all his shots are quite good. Frische and his family, consisting of Mrs. Frische, Freddy, Peggy, Nancy, and Jimmy get their recreation in the wide open spaces picnicking and camping. After a winter in New York, the family expects to add skiing to their recreation list. Frische admits to some piano playing, but says it is mostly for his own amusement.

Frische says he was born and reared in "Kaintuck," but homesteaded over Tennessee to get his bachelor's degree in 1935 from Maryville College. Back in Kentucky with this degree, he spent the next year as a graduate student at the University of Kentucky, then he went on to the University of Cincinnati where he received his master's degree (1938). It was about this time that he married Miss Eleanore Pflanze of Maryville. Indiana University awarded him a doctor's degree in 1943.

Career as Teacher

He was assistant professor of chemical engineering at Alabama Polytechnic Institute, Auburn, Alabama, 1941-'46, except for a period in 1944 when he was in Louisville, Kentucky, as development engineer in the gas processes division of the Girdler Corporation. Frische was professor of chemical engineering and metallurgy at Grove City College, Grove City, Pa., from 1946 to 1949 and did consulting work in the metals, petroleum and limestone industries there. He has been associate professor of chemical engineering at Clarkson College of Technology, Potsdam, New York, since January, 1949.

Frische is a member of the AIChE, ACS, ASEE, Alpha Chi Sigma, Tau BetaPi, and Phi Lambda Upsilon. He is a registered professional engineer in the State of Alabama.

High Honors Are Awarded Four Chemical Engineers

For his important contributions to separation processes in the petroleum industry, Dr. Mott Souders, Jr., head of the chemical engineering research section of Shell Development Company, San Francisco, was given the $1000 professional progress award in chemical engineering for 1949. Dr. Souders is well known for his development of a penicillin recovery process; a process for recovering toluene, used for dyes and explosives; and a method of calculating the size of a fractionating column, a device employed for breaking down crude oil into gasoline and other components.

Souders

Others receiving awards at the annual meeting of the American Institute of Chemical Engineers in Pittsburgh, early in December, were Edward G. Scheibel, William H. McAdams and Frederick E. Frey.

Scheibel, chemical engineer at Hoffman La Roche, Inc., was given the junior award of the American Institute of Chemical Engineers for his papers "Fractional Liquid Extraction" and "Principles of Extractive Distillation."

McAdams, professor of chemical engineering, Massachusetts Institute of Technology, is the third from MIT to receive the William H. Walker award for distinctive contributions to literature of chemical engineering. McAdams was cited "for his long series of authoritative publications in the field of heat transmission, represented in recent publications by the paper: 'Measurement of Recovery Factors and Coefficients of Heat Transfer in a Tube for Subsonic Flow of Air,' and others.

Dr. Frederick E. Frey, assistant director of research, Phillips Petroleum Company, received the 1949 southwest regional award for outstanding achievement in the field of petroleum chemistry.

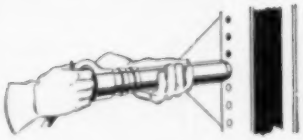
THESE ARE McKEE SERVICES TO THE PETROLEUM PROCESSING INDUSTRY

Plant Design and Engineering

McKee designs complete refineries, individual units for all processes and auxiliary facilities including steam and power plants.

Purchasing and Expediting

McKee buys all material and equipment, expedites procurement, makes necessary inspection and schedules arrival on the job at the proper time.



Construction and Installation

McKee field crews execute all stages of plant construction and installation of equipment from preparation of the site to completion of the project ready for operation.

McKee Experience

An inherent characteristic of all McKee services is *thoroughness*. This is a result of experience gained in repeatedly executing the multiplicity of details composing any large project. It is the factor that assures sound, practical design and engineering—prompt, economical procurement of materials and equipment—rapid, low-cost construction.

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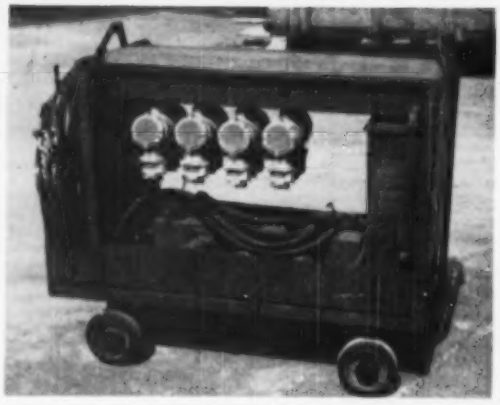
Maintenance and Operation

HOW TO DO IT

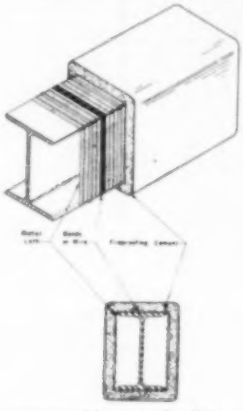
HOW—Portable Junction Box Aids Plant Work Crew

DURING a clean-out when members of a refinery maintenance crew are working inside furnaces, or columns, adequate illumination is important for rapid and efficient work. Equally important, is the elimination of hazards due to poor lighting. In one plant, power for lights is supplied from a portable junction box that can be wheeled to any point in the refinery. The box is mounted on a small wagon equipped with solid rubber-tired wheels. The wagon tongue folds up against the front of the unit and is clipped to prevent falling. A single heavy duty cable is supplied for connecting the junction box to a standard outlet. Eight separate extension cables can be plugged into the junction box.



HOW TO—Fireproof Steel Beams

STEEL, which engineering tests have shown will crumple after only 15 minutes of exposure to an intensely hot blaze, can be protected by use of a lightweight coating of fireproofing cement, which keeps beams and columns from collapsing in the event of fire.



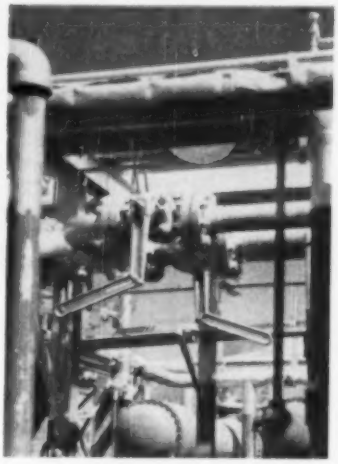
As shown in the photograph, the cement is applied with a trowel in a layer an inch and three-quarters thick to a steel beam wrapped with ribbed metal lath. This thickness is designed to retard the effect of heat for three hours.

The cement is extremely light in weight and easily and simply applied. It is designed to resist spalling or crumbling, retaining this ability under high pressure fire hose streams with the addition of an outer coating of harder material. The cement is a gray powder, which is mixed with water to form a stiff paste for troweling.

Photographs and material, courtesy Eagle-Picher Company, Cincinnati, Ohio.

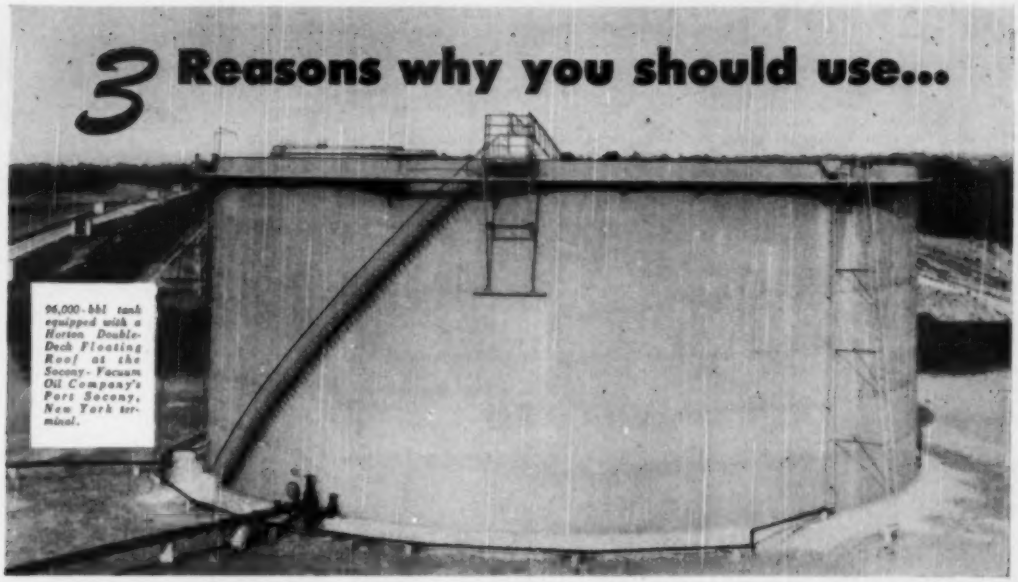
HOW—Overhead Plug Valve Wrenches Are Reshaped

A SIMPLE change in the form of plug valve wrenches permits overhead line valves to be opened or closed quickly and easily without using a bench or a stepladder. These, and other plug valves installed on horizontal overhead lines in a gasoline plant were fitted individually with wrenches to be left on the valve stems as a permanent installation. When the valves were opened, the ends of the wrenches pointed downward, sometimes presenting an obstruction about the height of a man's head. If the valves were to be closed, shoving the wrench handles to a horizontal position required a bench or stepladder.



To eliminate these difficulties, the wrench handles were cut in half and rewelded at an angle. The mitre cut was calculated to provide approximately a 60° bend in the handles, which raises the ends above head level and affords a quick and easy method of opening or closing the valves from the ground.

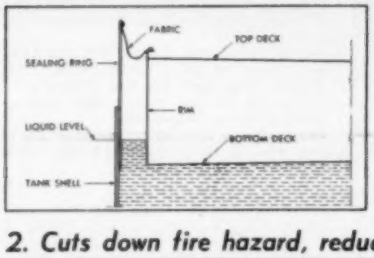
3 Reasons why you should use...



96,000-bbl tank equipped with a Horton Double-Deck Floating Roof at the Socony-Vacuum Oil Company's Port Socony, New York terminal.

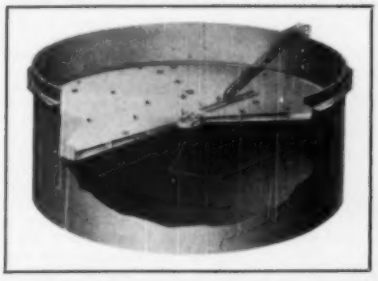
...HORTON Double-Deck Floating Roofs

1. Always efficient, even at high liquid levels

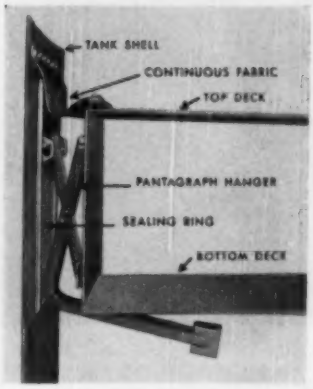


As the sketch at the left shows, tanks with Horton Floating Roofs can be filled until the sealing ring extends above the tank shell. Notice that the sealing ring retains its vertical position. Even if the liquid should accidentally overflow, the seal will not be damaged and the entire assembly of seal and roof will go back down into the tank safely and easily as the liquid level is lowered.

2. Cuts down fire hazard, reduces corrosion



The cut-away view at the left illustrates how this roof floats directly on the surface of the liquid and does away with the large vapor space found in cone-roof tanks. It blankets the surface of the liquid, preventing the contact of vapor and air necessary to support combustion. Corrosion is decreased too, because air is prevented from coming in contact with the underside of the roof.



3. Provides protection from evaporation losses

The improved Horton Seal, illustrated above, prevents the escape of vapor around the roof edge. The pantagraph hangers hold the sealing snugly against the shell and the continuous fabric closes the space between the deck and sealing ring.

CHICAGO BRIDGE & IRON COMPANY

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA

Atlanta 3	2146 Henley Building	Detroit 26	1320 Lafayette Building	Philadelphia 3	1608—1700 Walnut Street Building
Birmingham 1	1548 North Fiftieth Street	Havana	402 Abreu Building	Salt Lake City 1	1531 First Security Bank Building
Boston 10	1030—201 Devonshire Street	Houston 2	2126 National Standard Building	San Francisco 11	1251—22 Battery Street Building
Chicago 4	2463 McCormick Building	Los Angeles 14	1534 General Petroleum Building	Seattle 1	1331 Henry Building
Cleveland 15	2234 Guildhall Building	New York 6	3302—165 Broadway Building	Tulsa 3	1626 Hunt Building

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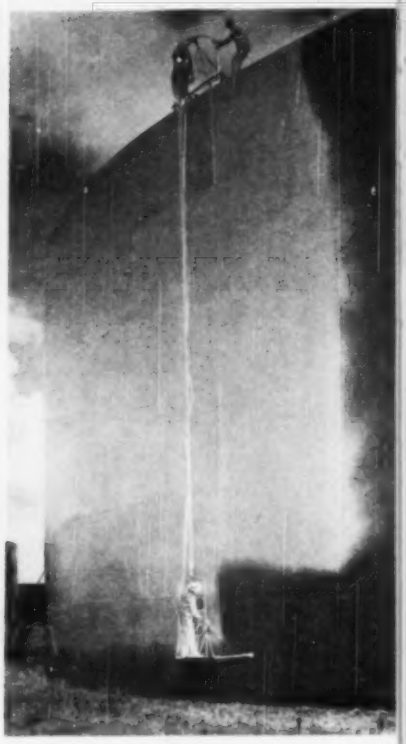
Comprimo N. V., Amsterdam—O, Netherlands

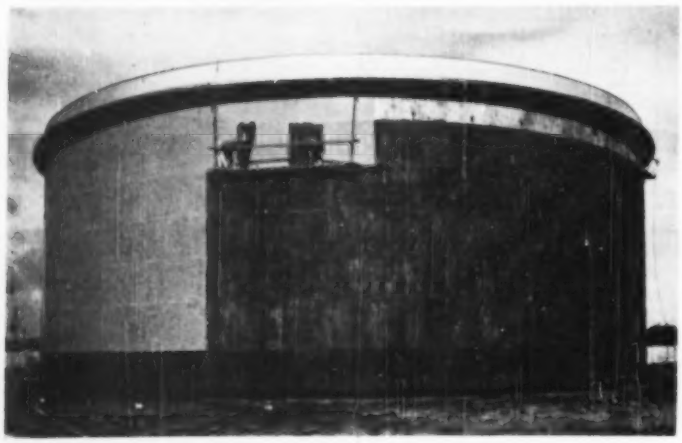
HOW TO—Protect Refinery Storage Tanks

PROTECTION from corrosion and reduced evaporation of products constitute the two most important reasons for application of paint to storage tanks in refinery operations. Last, but by no means least, however, paint is used to make the tanks attractive. For example, aluminum painted storage tanks, well maintained, appear pleasingly clean and are indicative of good housekeeping in the plant.

In any paint job, however, surface preparation and application of the protective coating is extremely important if the objectives of painting are to be realized. Extremely corrosive conditions on the Texas Gulf Coast reduce to about six years the life of a paint job, which lasts from 10 to 15 years over the rest of the State. Aluminum paint on storage tanks reduce evaporation losses an estimated 600 barrels per tank per year by reflecting the heat during the summer months. The savings from evaporation alone, obviously, are considerable when a large number of storage tanks are involved.

Tank painting is a well organized procedure with Humble Oil & Refining Company's storage tank maintenance crews. The program begins when the old paint scales and rust are scraped and buffed off with a pneumatic buffer in falls, which is a section about 20 feet wide from top to bottom of the tank. The crew works on the tank from a swinging scaffold, which is lowered from the top of the tank. When a fall has been cleaned, the crew brushes on a coat of red lead primer, then moves on the next falls to repeat the operation of cleaning and priming. This routine keeps





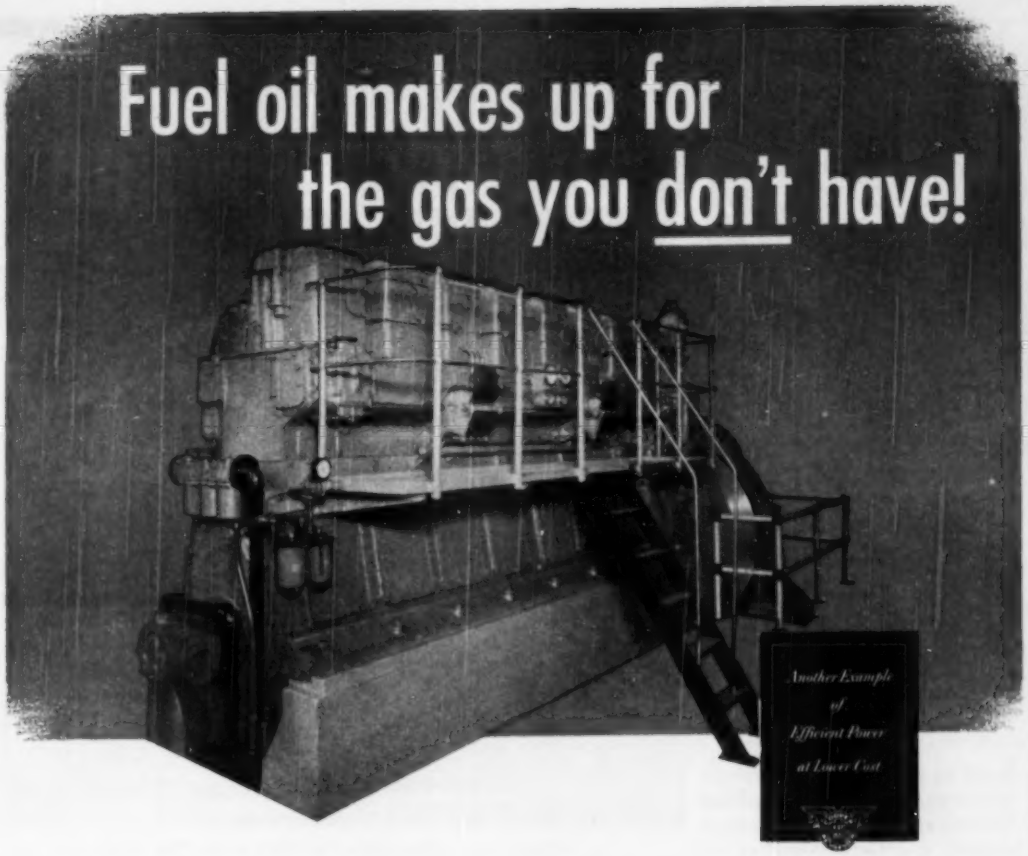
Left—Crew cleaning storage tank with pneumatic buffers to remove rust and scale.
Bottom—After "fall" has been cleaned, crew brushes on red lead primer, which prevents attack of rust on cleaned area.
Above—Painter spraying finish coat of aluminum paint on tank from bosun's chair, while helpers move A-frame buggy.

old paint scales and rust out of the new paint; fewer men are needed to work on a tank at one time, and the red lead priming coat is applied before corrosion has an opportunity to set in on the cleaned surface.

When the tank has been cleaned and primed, a second coat of red primer is sprayed on, and then a finish coat of aluminum is applied by spray gun. Spray painting is done from a bosun's chair swung from a movable A-frame buggy anchored to the center of the tank roof. Two men push the buggy along the edge of the roof and steady it while the painter does the spraying. After the tank hull has been painted, the roof is sprayed with a coat of an asphalt-petroleum type non-hard drying material that remains pliable. The superstructure is sprayed with aluminum, and black paint is brushed on the bottom ring of plates of the hull and the handrails.

An 80,000-barrel, floating-roof storage tank requires about 936 manhours and 356 gallons of various corrosion-resisting paints to cover the 70,000 square feet of its surface, according to Humble Pipe Line Company. The company has 750 tanks, ranging from 1000 to 140,000 barrels in size, and paints 70 to 100 tanks per year—all of which requires a lot of work and a lot of paint.

Fuel oil makes up for the gas you don't have!



Licking an old problem . . . .

Cooper-Bessemer gas-diesels are licking an old problem in field pumping and drilling operations. Where gas fuel is not available at the outset, wherever gas *is* available but in varying volume, these engines are ideal. Here's why . . .

They thrive on virtually *any* combination of oil and gas or on 100% fuel oil. They even adjust automatically for the slightest variation in gas supply. Thus you can always make maximum use of waste or low-cost gas, starting or falling back on full or partial oil operation as required.

That's not all! Recent Cooper-Bessemer refinements make these engines sensationally economical *even at fractional loads* . . . the highest thermal efficiencies ever reached in practical heat engines. The gas goes farther!

Why not get complete, specific information as applied to your conditions? The nearest Cooper-Bessemer office will be glad to explain how you can save . . . *and save!*

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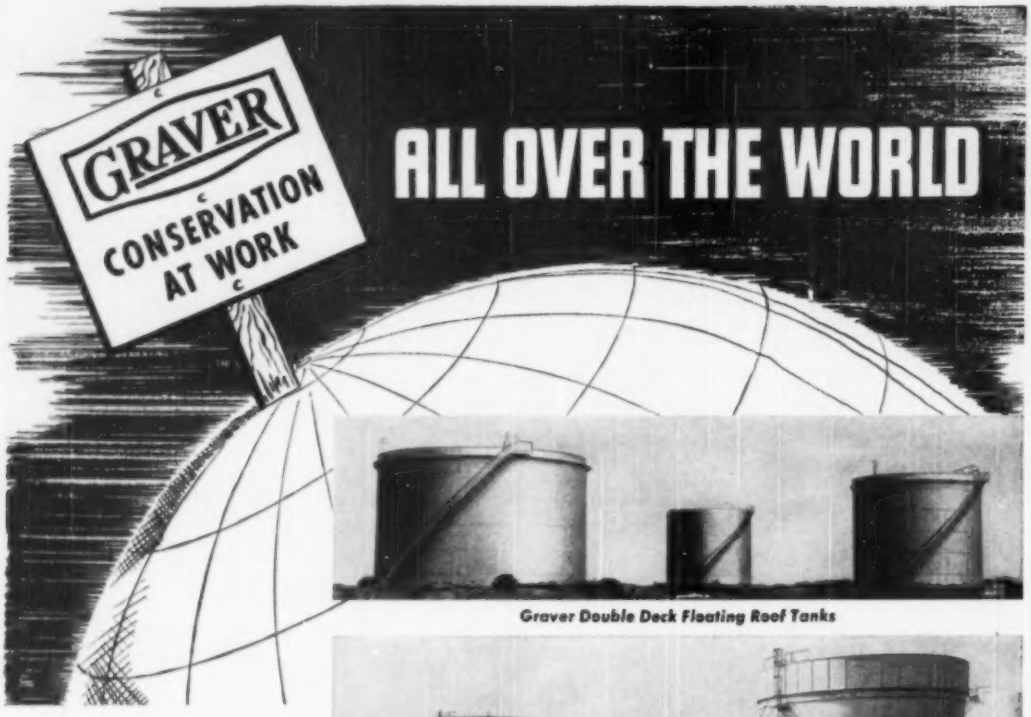
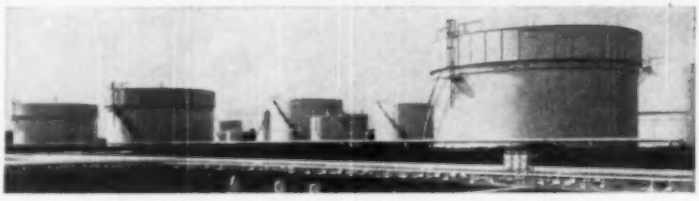
Seattle, Wash. Tulsa, Okla. Shreveport, La. St. Louis, Mo. Los Angeles, Calif.
Caracas, Venezuela Gloucester, Mass. Calmes Engineering Co., New Orleans, La.

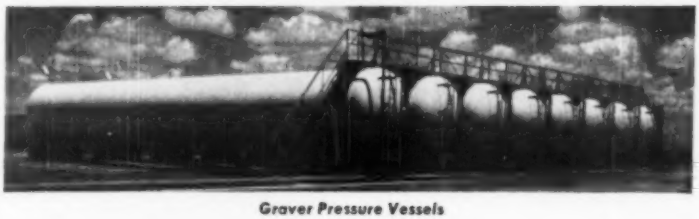


Graver Double Deck Floating Roof Tanks



Graver Expansion Roof Tanks Manifolded to Cone Roof Tanks

Graverspheres



Graver Pressure Vessels

Look at refineries and terminals wherever you go and you will see Graver conservation equipment at work, positively preventing vapor losses for producers, refiners, and marketers. The proven performance of the Graver Expansion Roof makes it the choice of the world's leading oil and pipe line companies . . . and the records of savings with Graver Floating Roofs, Pressure Vessels and Graverspheres are equally convincing.

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The MONTH... in the INDUSTRY

Perkin Medal Recipient Says Research Is Backbone to Higher Living Standard

The highest award of the Society of Chemical Industry—the Perkin Medal for 1950—was awarded Eger V. Murphree, president of Standard Oil Development Company, central research affiliate of Standard Oil Company (New Jersey) in New York early this month.

Murphree

In his acceptance, Murphree said that industry's faith in research and the expenditure of capital to back up that faith are major factors in increasing the standard of living, declaring that "the development of new or improved products and techniques in our industries, provides for continuing high rates of employment."

The meeting was a joint affair of the American Chemical Society, American Institute of Chemical Engineers, the Electrochemical Society and the American section of the Society of Chemical Industry. Murphree was the forty-fourth recipient of the medal which was founded in commemoration of the 50th anniversary of the coal tar color industry, 1856-1906.

In illustrating the cost of research to achieve workable processes, Murphree pointed to three major projects initiated by Standard Oil Development Company. Cost up to now of development of butyl, described as a basically safer rubber for inner tubes, was put at $11 million. The fluid catalytic cracking process, cost $9 million when the first plant was completed, he added, and to develop the process for making synthetic toluene, the final expenditure was another $2 million.

"In most cases very substantial costs in research and development were involved before there was any assured commercial success," he said. This would indicate that the bulk of new industrial development will result from the work by large organizations, although important developments have and will continue to result from the research work of smaller firms and individuals. The incentive for the financial risks involved in creating these developments comes from the expectations of profit for those which are successful. I hope we never see the day when through restrictive legislation or other government action, this expectation ceases to exist."

Murphree holds some 21 patents ranging from obtaining oxidation products from hydrocarbons to method and apparatus for contacting solids and gases and has published more than 25 papers on synthetic rubber, catalytic cracking and application of the fluid solids technique to producing synthetic liquid fuels.

Other business connections include Solvay Process Company, Standard Oil Company of Louisiana and Standard Oil Development Company where he has been vice president, and executive vice president.

Bureau Figures Predict Oil Rise of 3.5 Percent

Indications the last week of December were that the Bureau of Mines forecast for 1950 would probably show a 3.5 percent rise in total demand over 1949. This is assuming normal weather and no interruptions in business activity, as well as taking into account increasing natural gas competition for fuel oil markets in the northeast and midwest.

Also indicated were an excess of a 10 percent rise in heating oil demand, as against 1949's drop of around 3 percent compared with 1948; a decline in residual oil demand about in line with what the bureau regards as normal downward trend, 1 to 2 percent; an increase in motor fuel demand of a further 4 to 5 percent or to nearly 2.6 million barrels per day; and that imports will care for 1 to 1.5 percent of the rise in total demand for all oils, and other sources about as much, which would mean higher demand for domestic crude of not more than 1.5 percent.

Use of Tracers Outlined

Use of radioisotopes by oil companies will reduce manufacturing and transportation costs of petroleum products according to a December prediction by Logan B. Emlet, director, operations division, Oak Ridge National Laboratory. Emlet said that some oil companies are distinguishing between different grades of oil flowing through a pipe line by adding a small amount of radioactive barium to the line at the point separating the two liquids. A Geiger counter gives positive indication of interface between liquids at any point in line. (Also see page 131.)

TEXACO PLANT DEDICATED — Governor Alfred E. Driscoll of New Jersey dedicated The Texas Company's new $60,000,000 refinery at Westville, N. J., on November 29. Photo shows Governor Driscoll throwing the switch which blew the refinery whistle, officially placing the plant in operation. To be known as Eagle Point Works, the new plant will process 40,000 barrels of crude oil per day.

Photo shows Harry T. Klein, Texaco president, Governor Driscoll, Michael Halpern, vice president in charge of refining, and A. M. Martin, superintendent of the new plant, who officiated at opening ceremonies.

See page 124 for other Westville refinery information.

Independent Refiners Organize in 25 States

Independent Refiners Association of America, a new national organization which had its beginning in Chicago during the recent American Petroleum Institute meeting, has been organized in 25 states to act as a spokesman for independent oil refiners on local, state and regional levels. Headquarters are in Houston. Harry Leyendecker, vice president of Eastern States Petroleum Company, and temporary chairman of the association's executive committee said that the IRAA will also carry on an educational program within the oil industry and work with members of Congress and congressional committees to present independent refiners' viewpoint on legislation affecting the industry.

"Conditions in the industry which have led in recent months to closing of independent refineries have created an emergency," he said. "The association will work by all lawful and legitimate means to prevent additional closings and, in cooperation with other units of the oil industry and with the understanding and help of the general public, to bring about conditions which will enable the independent refiners to survive."

Other members of the executive committee include Robert O. Anderson, president, Malco Refining, Inc.; James P. Dunnigan, president Producers Refining, W. Branch, Mich.; D. E. Foster, president Wisconsin Oil Refining Company, Sheboygan, Wis.; M. Lloys Freese, vice president, Bell Oil & Gas Company, Tulsa; D. W. Hovey, president, Danaho

The MONTH...

Refining Company, Houston; Fred C. Koch, president, Wood River Oil & Refining Company, Wichita, Kans.; and M. H. Robineau, president, Frontier Refining Company, Denver Colo.

In the future, the association plans to set up machinery in each major oil producing state and region represented by the IRAA membership to provide a local spokesman for the association and means of handling local matters.

Refiners who attended the initial meeting in Chicago, and others who have been invited to join the association, are located in Alabama, Arkansas, Colorado, Illinois, Indiana, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Montana, Nebraska, New Mexico, New York, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Texas, Utah, West Virginia, Wisconsin and Wyoming.

Zeder SAE President, Other Officers Named

The Society of Automotive Engineers has elected James C. Zeder 1950 president. Zeder, chairman of the engineering board of Chrysler Corporation, was previously chief engineer of the corporation's labs since 1933. He is a graduate of the University of Michigan and holds

Zeder

Fox

an honorary master's degree from Lawrence Institute of Technology and an honorary doctor's degree from the University of Dayton.

Other officers named include vice presidents as follows: Albert H. Fox, Standard Oil Company (Indiana), diesel engine activity; Matt E. Nuttila, Cities Service Oil Company, transportation and maintenance activity; Arthur O. Willey, The Lubrizol Corporation, fuels and lubricants activity. R. J. S. Pigott, Gulf Research and Development Company, a past president, is a member of the council.

Processing Firm Formed To Operate Atlas Refinery

Four natural gasoline and refining companies have purchased the facilities of Atlas Oil & Refining Company and have formed Atlas Processing Company to operate Atlas Refinery and Pipe Line interests. Consideration was reported as $1.3 million. Purchasers include Carthage Corporation, United Gas Pipe Line Company, Triangle Refining Company, and The Chicago Corporation, which heads the group. The new company will upgrade material extracted in the Carthage area of East Texas. Headquarters will be in Shreveport, La.

Officers of the new company are J. B. Atkins, president; Vernon B. Chance, vice president and general manager; J. B. Saunders, Houston, vice president; and J. I. Polk, Shreveport, secretary-treasurer. The board of directors is comprised of E. J. Hudson and Saunders, Houston; Harvey McLean, Ed Parkes, A. H. and C. H. Williams of Corpus Christi.

API Announces Program For 1950 Refining Meet

Seven technical sessions covering corrosion, training, waste disposal, automotive fuels, analytical research, new processes and refinery maintenance will comprise the program for the American Petroleum Institute's 1950 midyear meeting of the division of refining to be held May 1-4 in Cleveland, Ohio. Chester F. Smith, Standard Oil Company (New Jersey), New York, and API vice president of refining, in announcing the program, said the regular committee meetings will also be included.

Smith

Papers to be submitted for the various sessions should be addressed before the March 1 deadline to W. T. Gunn, director of refining division, American Petroleum Institute, 50 West 50th Street, New York 20.

Sun Director Retires

William D. Mason, director in charge of industrial relations, Sun Oil Company, has retired after 45 years in the petroleum industry. Mason will continue on the board of directors until the annual meeting of stockholders in April 1950. William E. Zimmerman is Mason's successor as director of industrial relations.

Mason joined Sun Oil Company in 1926 as manager of the Marcus Hook refinery after 22 years in oil refineries on the west coast. He has been a member of the board since 1947.

Zimmerman has been assistant manager of the industrial relations department since 1944, previously serving as assistant superintendent in charge of personnel at the Marcus Hook refinery.

Superintendent Moved In Pennzoil Personnel Change

J. M. Hinman, general superintendent of The Pennzoil Company's refinery, has been transferred to the general office, Oil City, Pa., as manager of research and development, A. V. Hoffman, former assistant superintendent, succeeds him.

H. A. Weymouth, who has been division manager of the western division, Kansas City, Mo., will retire. R. S. Lockton will be western division manager, Kansas City, Kan. R. K. Peppard will be division manager of the southwestern division at Oklahoma City. Both divisions were subdivided from the company's western division. Permanent headquarters will be established in the southwest at a later date.

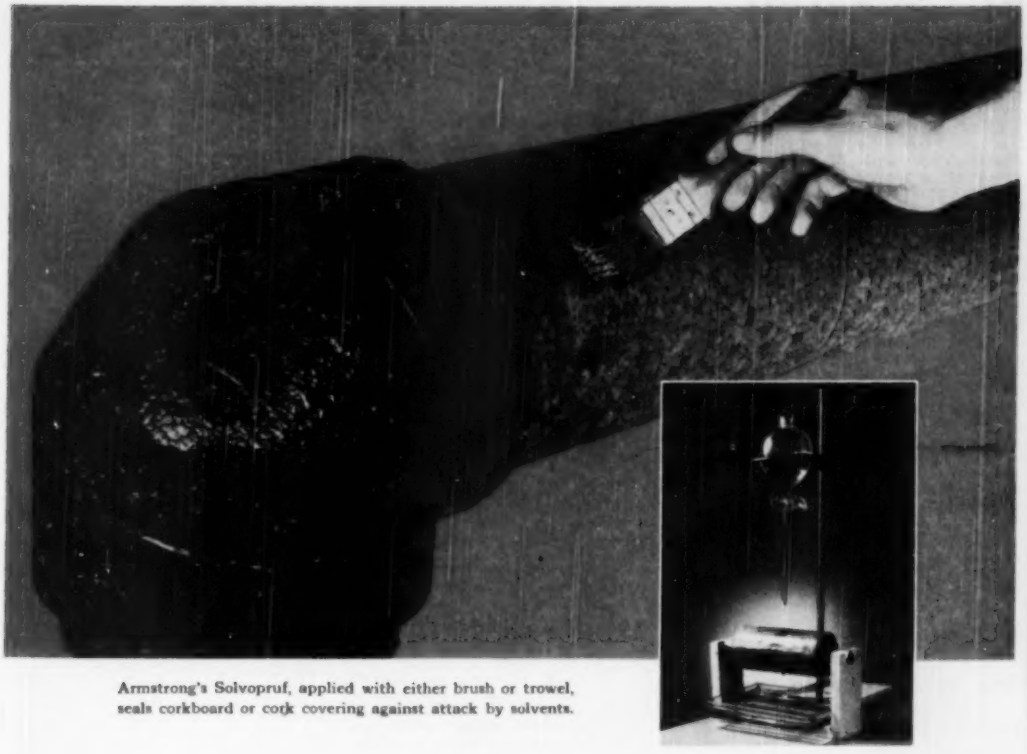
THE OIL MAN'S CALENDAR

1950	
JAN.	
23-27	**American Society of Heating and Ventilating Engineers, Annual Meeting, Dallas.**
30 to Feb. 3	**American Institute of Electrical Engineers, Winter General Meeting, New York, Hotel Statler.**
FEB.	
4- 8	**Air Pollution Training Course, University of Michigan School of Public Health, Ann Arbor, Mich.**
9-10	**Southern Gas Association, Meter and Regulator Conference, Houston.**
12-16	**American Institute of Mining and Metallurgical Engineers, Annual Meeting, New York, Hotel Statler.**
15-17	**Spectroscopy Society of Pittsburgh, Conferences on Analytical Chemistry and Applied Spectroscopy, Pittsburgh, William Penn Hotel.**
20-24	**American Society for Testing Materials, Committee, D-2 on Petroleum and Petroleum Products, Spring Meeting, Washington, D.C., The Shoreham Hotel.**
27 to Mar. 2	**American Society for Testing Materials, Pittsburgh, William Penn Hotel.**
MAR.	
6- 9	**American Road Builders Association, Annual Meeting, (Including Airport Division), Cincinnati, Netherlands Plaza Hotel.**
13-16	**National Electrical Manufacturers Association, Chicago, Edgewater Beach Hotel.**
27-29	**Western Petroleum Refiners Association, 38th Annual Meeting, San Antonio, Plaza Hotel.**
APRIL	
3- 5	**Society of Automotive Engineers, Aeronautic and Air Transport, New York, Hotel New Yorker.**
4- 7	**National Association of Corrosion Engineers, Annual Conference and Exhibit, St. Louis, Jefferson Hotel.**
5- 7	**Illinois Institute of Technology, Midwest Power Conference, Chicago, Sherman Hotel.**
10-14	**American Society of Mechanical Engineers, Washington, D.C., Hotel Statler.**
11-13	**Southwestern Gas Measurement, Short Course, Norman, Okla., University of Oklahoma.**
12-14	**National Petroleum Association, Cleveland, Ohio, Hotel Cleveland.**
24-25	**Industrial Accident Prevention Association, Toronto, Canada, Royal York Hotel.**
24-26	**Natural Gasoline Association of America, Annual Convention, Fort Worth, Texas, Texas Hotel.**
24-26	**American Society of Mechanical Engineers, Process Industries, Pittsburgh, William Penn Hotel.**
MAY	
1- 4	**American Petroleum Institute, Division of Refining, Mid-Year Meeting, Cleveland, Ohio, Hotel Cleveland.**
7- 9	**Independent Petroleum Association of America, Twenty-first Mid-Year Meeting, Los Angeles, Biltmore Hotel.**
8- 9	**American Gas Association, Natural Gas Department, Spring Meeting, Tulsa, The Mayo Hotel.**
8-11	**Liquefied Petroleum Gas Association, Annual Convention and Trade Show, Chicago, Palmer House.**
15-17	**Oil Industry Information Committee, Chicago.**
15-18	**National Fire Protection Association, American Gas Association Exhibit, Atlantic City, N. J., Haddon Hall.**

CCA Savings Suffer Drop

Net savings for patrons of Consumers Cooperative Association and its subsidiary Cooperative Refinery Association dropped 99 percent during the fiscal year ending August 31, 1948, according to H. A. Cowden, president. Savings of $8 million at that time dropped to $86,334 for the fiscal year ended August 31, 1949. CCA lost money on its refining operations, Cowden said, but gained in crude oil production.

Refineries reached a new high in crude oil processed, averaging 19,678



Armstrong's Solvopruf, applied with either brush or trowel, seals corkboard or cork covering against attack by solvents.

How to protect insulation from attack by solvents

Cork insulation can now be thoroughly protected against the deteriorating effects of solvents. This is made possible by Solvopruf, a new compound developed by Armstrong. Solvopruf resists the liquid solvents and fumes that may attack vital insulated cold lines in chemical process plants and refineries.

This new product is specially formulated for use either as an adhesive or a protective finish. It is a self-curing compound that can be applied by brush or trowel and sets to a rubberlike film in two hours at room temperatures. It will remain in this condition when exposed to temperatures from 35° below zero to 125° F. After about a week of aging, Armstrong's Solvopruf is resistant to the action of toluol, methyl ethyl ketone, gasoline, kerosene, water, and benzol.

In one oil refinery where solvent vapors are a special problem, Armstrong's Solvopruf was applied three years ago to cork covering on cold lines. In this test, as well as in extensive testing in Armstrong's Research Laboratories, Solvopruf has satisfactorily withstood solvent attack.

Meeting and solving all types of insulation problems is part of the day-to-day work of Armstrong's Contract Service. This complete contracting organization offers buyers of low-temperature insulation a complete package, including qualified engineering advice, efficient materials, and skilled mechanics to apply them. For full information on this service, write today for the free booklet, "People Make A Good Insulation Job." Armstrong Cork Co., 7501 Concord St., Lancaster, Penna.

ARMSTRONG'S INDUSTRIAL INSULATIONS

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The MONTH...

barrels per day during the last fiscal year, up 2270 barrels per day from the preceding fiscal year or 13 percent. Codden said that while this provided an increase in refined fuels, lubricating oil production slumped below previous year's record output. He said that total net sales of refined fuels reached 6.5 million barrels during last fiscal year, up 16 percent from the previous year.

Ethyl Vice President

Joseph A. Costello has been named vice president of Ethyl Corporation. He has been with the company for more than 20 years and has been assistant general manager of manufacturing for the past five years. He first joined as a field representative in the sales department and served subsequently as manager of the Atlanta and New York sales divisions.

Costello

For two years during the war Costello was on leave of absence as special assistant to the director of refining in the Office of the Petroleum Administration for War in Washington, D. C.

Spectroscopy Conference

An exposition of modern analytical equipment will be featured at the Pittsburgh conference on analytical chemistry and applied spectroscopy, jointly sponsored by the analytical division of the Pittsburgh section of the ACS and the Spectroscopy Society of Pittsburgh. During the conference, February 15-17, sessions will be held on analytical chemistry, infrared spectroscopy, emission spectroscopy, ultraviolet absorption spectroscopy, and specialized techniques.

Socony Paint Division Adopts New Company Name

A change in name to Socony Paint Products Company, has been made by the Socony paint products division of Socony-Vacuum Oil Company, Inc. S. G. Lansing is president of the company.

The company operates a new paint plant at Metuchen, N. J., and a division office at 59 East Van Buren Street, Chicago. For nearly 70 years manufacturing operations were carried on in Long Island City, N. Y. Other manufacturing plants of the company are in Beaumont, Texas, and Los Angeles.

Freedom Valvoline Sold To Ashland Oil & Refining

Freedom Valvoline Oil Company has been sold to Ashland Oil & Refining Company and will continue to operate as a separate organization, according to Paul G. Blazer, board chairman of Ashland and director of the other company. William G. Bechman, board chairman of Freedom Valvoline Oil Company, who becomes director of Ashland Oil & Refining Company, said that inheritance and income taxes forced sale of the company.

Socony Medical Director

Dr. George M. Saunders, associate director of the medical department of Monsanto Chemical Company, has been appointed medical director for overseas operations of Socony-Vacuum Oil Company, with headquarters in New York. He has been with Monsanto Chemical Company since 1947.

Celebrates Fifty Years With Stone and Webster

William N. Patten, a director of Stone & Webster Engineering Corporation and former vice president, was honored last month by his associates at a dinner celebrating his 50th year of service with the company. A bronze plaque was also given him by J. R. Lotz, chairman of the board, on behalf of the General Safety Committee, in recognition of his leadership in accident prevention work and his contributions to the company's construction activities.

Patten joined Stone & Webster Engineering Corporation shortly after graduating from the University of Maine in 1891. He has served successively as draftsman, chief draftsman, engineer, and construction manager. In 1928 he was elected vice president and director of the corporation. In 1941 he received the honorary degree of doctor of engineering from his alma mater. He resigned as a vice president in 1948 but has continued as a director.

Bahrein-Caltex Group Make Executive Changes

Pinckard

Bramstedt

William Henderson Pinckard, president of The Bahrein Petroleum Company Limited and of California Texas Oil Company, Ltd., since 1946, has become chairman of the board of directors and chief executive officer of the Bahrein-Caltex group of companies. William Frederick Bramstedt, director and executive vice president, will succeed him as president.

Safety Council Award Given Whiting Plant Foreman

The National Safety Council award of merit was given A. J. Olson, tin shop foreman, in the mechanical division of Standard Oil Company (Indiana) Whiting refinery, on the occasion of his recent retirement. The department which employs 89 men, has achieved, under his supervision, a record of 29 years without one lost-time accident, plus 2.3 million accident-free man-hours. This was the first time that the award was given to a person not exclusively in safety work. Olson joined the company as a tinner 36 years ago and has been tin shop foreman since 1916.

Magnolia Refining Division Makes Three Staff Changes

Douglas N. Ezzell, former chief process engineer at Magnolia Petroleum Company's Beaumont refinery, has been transferred to Arabian American Oil Company as superintendent of manufacturing at the Ras Tanura refinery on the Persian Gulf. Ezzell joined Magnolia Petroleum Company in 1937, serving as chief process engineer over the technical department's light oil section, and in 1947 over the planning and coordinating section. Curtis M. Klaerner, who takes over Ezzell's position, is succeeded by Eber H. Peters, Jr., as assistant chief process engineer in the section.

Roy M. Ferris has been elected chairman of the Sabine subsection of the American Society of Mechanical Engineers. He is with the planning and scheduling section, engineering department of the Beaumont refinery of Magnolia Petroleum Company. John Petkovsek, engineering department, was elected chairman of the Beaumont-Port Arthur chapter of the Institute of Radio Engineers. Clyde B. Trevey, also with the engineering group, was named secretary-treasurer.

Heads Petroleum Institute

The Council of the Institute of Petroleum, located in London, has nominated C. A. P. Southwell president of the 1950 session. Southwell, managing director of Kuwait Oil Company Ltd., was previously manager of Fields and Geolog-

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Anaconda Duplex Tubes

ANACONDA Duplex Heat Exchanger Tubes on request are supplied with the ends of the external tube cut back to receive ferrules for rolling into the tube sheet. Ferrules can also be supplied.

ANACONDA Duplex Tubes are available in a wide range of metals. These tubes can be supplied with the copper or copper alloy drawn either inside or outside of the steel tubing. For example, in a diethanolamine stripper, a copper-steel combination is called for, with copper on the outside of the tubes to resist corrosive steam and steel on the inside to resist attack by the amine.

For general information on ANACONDA Duplex Tubes write for Publication B-2. And remember that ANACONDA metallurgists are always ready to help you solve your tube problems. Address The American Brass Company, Waterbury 88, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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For efficient heat transfer

ANACONDA Heat Exchanger Tubes

The MONTH...

ical Branch, Anglo-Iranian Oil Company, Ltd. In 1936 he was elected to the council of the Institute and in 1948 was made a vice president.

1950 Instrument Exhibit

The fifth national instrument conference and exhibit, sponsored by the Instrument Society of America, will be held in the Memorial Auditorium, Buffalo, N. Y., September 18-22.

Lab Finds Cobalt 60 Useful In Industrial Radiography

St. John X-Ray Laboratory, Califon, N. J., claims to be the first lab to use Cobalt 60, a radioactive material, for industrial radiography, in place of radium. The lab, which has received a 350 millicuries source of radioactive Cobalt 60, claims that since the material has a smaller focal spot size than the equivalent amount of radium, better results can be obtained by the use of this new radioisotope. Applications to any field job are offered by the lab, which has designated a separate building for exclusive use of the material.

Names in the Industry News

B. Bynum Turner, for the last two years coordinator of Ethyl Corporation's $40 million plant expansion program, has been appointed general manager of manufacturing at the Baton Rouge, La., plant. He succeeds **John H. Schaefer,** vice president and director, who returns to New York to direct manufacturing operations from the company's headquarters. **Clinton W. Bond** will continue as resident manager in charge of the Baton Rouge plant.

Turner

Roy J. Diwoky, assistant to the president of Pan-Am Southern Corporation has been elected a vice president. Diwoky was formerly an executive in the manufacturing department of Standard Oil Company (Indiana). In June 1949 he joined the board of directors of Pan-Am Southern Corporation's predecessor company.

Warren L. McCabe, vice president and director of research of The Flintkote Company, has been named president of the American Institute of Chemical Engineers for 1950. Other officers are **T. H. Chilton,** Vice President, technical director of the development engineering division, E. I. du Pont de Nemours & Company; Secretary **S. L. Tyler**; and Treasurer **C. R. DeLong.** New directors include **C. G. Kirkbride,** vice president in charge of research and development, Houdry Process Corporation, Marcus Hook, Pa.; **W. G. Whitman,** head of department of chemical engineering, Massachusetts Institute of Technology; **G. E. Holbrook,** assistant director of the technical division, organic chemicals department, E. I. du Pont de Nemours & Company; and **R. L. Murray,** executive vice president, Hooker Electrochemical Company, Niagara Falls.

Bert Pershing Newton, vice president in charge of foreign marketing operations for Gulf Oil Corporation, has retired. Newton has also retired as vice president and a director of Gulf Refining Company, vice president of Gulf Research & Development Company, and a director of Kuwait Oil Company, Ltd. He joined Gulf Oil Corporation in 1921. He is succeeded by William A. Berryman as vice president of Gulf Oil Corporation's foreign marketing operations.

William Klabunde has joined Houdry Process Corporation in Philadelphia as a patent attorney in engineering. Klabunde, a graduate of the New York Law School, studied engineering at Steven's Institute of Technology. He has also been patent attorney with Western Union Telegraph Company.

Dr. George Granger Brown, head of the department of chemical engineering at the University of Michigan, has been appointed director of engineering for the Atomic Energy Commission. Dr. Brown, who is particularly well known for his work in the field of distillation, has been on the chemical engineering staff at the University of Michigan for 25 years and has been head of the department since 1942. In his new position, he will be on a one-year leave of absence from the university.

Executive Promotions Made By Universal Oil Products

Venema

Bockman

M. P. Venema, former head of the patent department of Universal Oil Products Company, has been elected a vice president by the board of directors. George A. Bockman, previously assistant treasurer, is now treasurer.

A graduate of Armour Institute of Technology (now Illinois Institute of Technology) and Georgetown University of Law, Venema has been with the company since 1935. He represented the company's patent department in Washington from 1941 to 1944 and in June directed that department's activities in Chicago.

Bockman has been with Universal Oil Products Company since 1922, serving as purchasing agent and then assistant treasurer.

Dr. Wilbur H. Miller has been appointed technical representative and assistant manager of American Cyanamid Company's Washington, D. C., office to act as liaison between various governmental laboratories and the company's technical facilities. Dr. Miller has been on the staff of the company's Stamford research laboratories since 1941 and has several publications and patents for his work there in organic synthesis, chemotherapeutic agents and enzymes.

Millard G. Gamble has been named president of Esso Shipping Company, a subsidiary of Standard Oil Company (N.J.). All activities of the latter's marine department and shore and sea-going personnel will be transferred to the shipping company. Other officers of Esso Shipping Company are **John J. Winterbottom,** executive vice president; **John D. Rogers,** vice president; **Clinton DeWitt,** treasurer-comptroller, and **Edmund A. Flotten,** secretary.

Roy S. Reed, former industrial relations supervisor at Stanolind Oil and Gas Company's North Texas-New Mexico division office in Fort Worth, has been transferred to general offices in Tulsa as labor relations supervisor. **Walter E. Forry** will be personnel supervisor in Tulsa. He was former division industrial relations supervisor in the Texas-Louisiana Gulf Coast division office, Houston.

Joseph A. Costello, who has been elected vice president of the Ethyl Corporation, has been with the company more than 20 years and has been assistant general manager of manufacturing for the past five years. He first joined Ethyl as a field representative in the sales department and served subsequently as manager of the Atlanta and New York sales divisions. During the war he was special assistant to the director of refining of PAW.

Dr. Donald G. Zink, has been named general superintendent, chemicals products department for Stanolind Oil and Gas Company. He will be in charge of all commercial development and marketing in the field of chemicals. Previously, he was director of technical development for U. S. Industrial Chemicals, Inc., before joining Stanolind Oil and Gas Company in 1947.

Larry L. Smith, former Stanolind's chief synthesis project engineer, is now superintendent of the Brownsville, Texas plant. Smith has been with the company since October, 1946, when he joined as a project engineer.

Lucian W. Carter, personnel manager of Shell Oil Company's Wilmington, Calif., refinery, retired January 1, 1950 after more than 23 years of service with the company. He had held the post since February, 1930 except for one year, in the Los Angeles office. **R. A. Pratt,** who will succeed Carter, for the past year has been assistant personnel manager, Los Angeles office, and prior to that was personnel manager of Shell Chemical Corporation, Houston.

André E. Briod, for 18 years with Nopco Chemical Company, formerly

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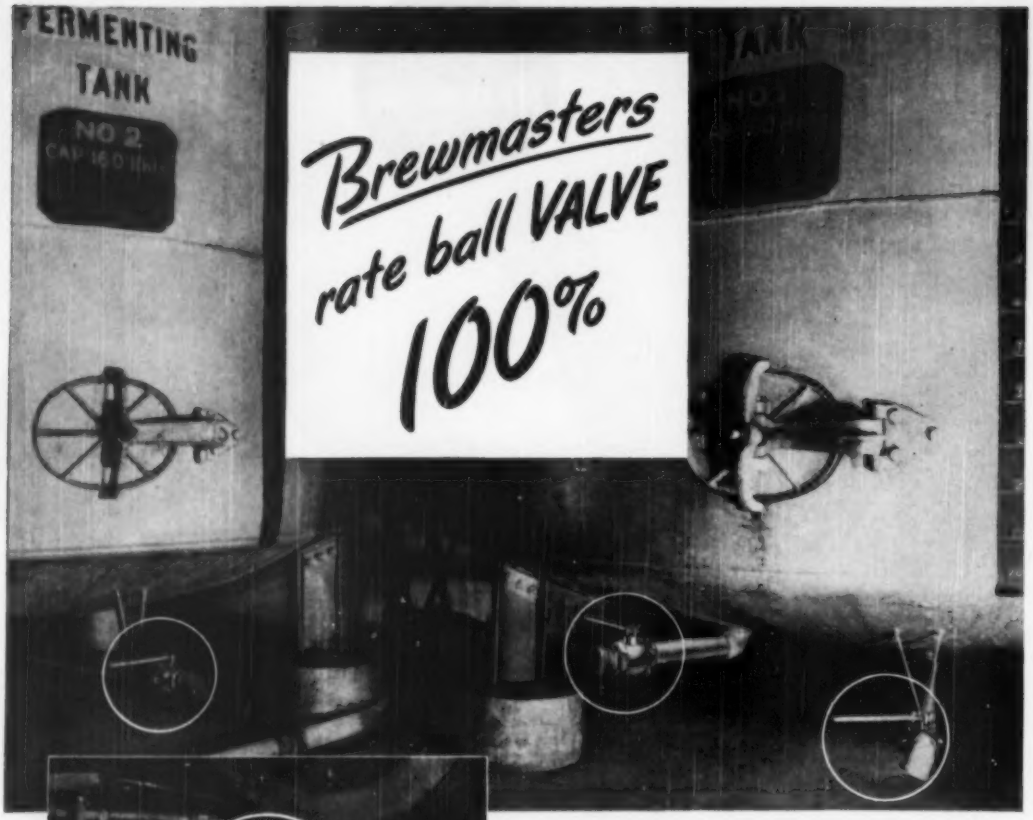

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National Oil Products Company, is now connected with R. S. Aries & Associates, New York consulting engineers. Briod will be chiefly concerned with commercial chemical development problems.

C. Elmer Townsend, manager of Sun Oil Company's insurance department for the past 31 years, has retired. He was employed by the Pennsylvania Railroad for 18 years before joining Sun Oil Company.

Reese H. Taylor has been re-elected as president of Western Oil & Gas Association and **John M. Pierce** has been named vice president and general manager. Pierce was former executive secretary, a post which the association has abolished. All other officers were re-elected.

Promotions Announced as Fluor Names Sales Heads

Fluor Corporation, Ltd., has appointed George Dieter, general sales manager,

Mellon

Dieter

Los Angeles, P. D. Mellon, Canadian representative, Calgary, Can., and R. E. Nagel, assistant sales manager in charge of Chicago sales office.

Dieter has been with the company since 1940 serving as assistant project engineer, district sales engineer, and manager of manufacturing sales. Mellon, previously with Calgary and Emerson Gas Company, is the first permanent resident to represent the company in petroleum and allied industry design, engineering, and construction projects in western Canada. Nagel was associated with Universal Oil Products Company from 1921 to 1945 when he joined Fluor Corporation, Ltd., as head of the New York sales office until 1946.

Nagel

LPGA Sets May Meet

Sales and service will be the keynotes of the Liquefied Petroleum Gas Association's convention and trade show to be held May 8-11 in Chicago. Also scheduled are talks by industrial leaders on these subjects, and a progress report on the recently launched national LP-Gas promotion.

New Houdry Offices

The principal offices of Houdry Process Corporation have been moved to 1528 Walnut Street, Philadelphia 2. Former headquarters were at 225 South 15th Street.

Shell Research Conference On By-Products from Crude

Dr. M. F. Spaght, president of Shell Oil Company, and J. H. "Jimmy" Doolittle, vice president, were among those attending the company's semi-annual research conference at the San Marcos, near Phoenix, Ariz., December 5-12. Others present were A. J. Johnson, vice president, F. S. Clulow and C. E. Davis, vice presidents of Shell Oil Company, and W. P. Gage, vice president of Shell Chemical Corporation. Scientists from Shell research laboratories at Houston, Wood River, Ill., and Martinze and Emeryville, Calif., also participated in the discussions which were aimed at planning future scientific investigation for pr ducing greater amounts of products from crude oil.

Follis Succeeds Collier

H. D. Collier has resigned as chairman of the board of directors of Standard Oil Company, of California, effective December 31, 1949, but will continue as a director and chairman of the finance committee.

R. G. Follis, vice chairman and formerly president, will succeed Collier as chairman and T. S. Petersen, who was elected to the presidency on January 8, 1948, will continue in that office.

Du Pont Gives $100,000 In Grants to Universities

A $10,000 non-restricted grant-in-aid for 1950-51 has been granted to each of the following ten universities by E. I. du Pont de Nemours and Company, Inc.: California Institute of Technology, Cornell University, Harvard University, Massachusetts Institute of Technology, The Ohio State University, Princeton University, Yale University, University of Illinois, University of Minnesota, and University of Wisconsin. The company also provided $20,000 to the University of Chicago for a calendar year 1950 membership in its institute for the study of metals.

The company's plan which was inaugurated in 1948 on a trial basis with the aim of increasing the amount of such research being done in this country. The plan specifies that the universities themselves select the research projects for which the grants will be used. Funds are not included for construction or endowment, but for operating expenses, purchase of chemicals, apparatus, or equipment needed in the conduct of research.

The MONTH...

DEATHS

Herbert E. Nunnery of Jackson, Miss., special representative of the American Petroleum Industries Committee of the API died in Jackson, Miss., December 16. A graduate of the University of Mississippi law school, Nunnery was assistant attorney general of the state of Mississippi. From 1933 to 1942, he served as executive secretary of the Mississippi Petroleum Industries Committee.

Fred G. Bannerot, Sr., veteran Pennsylvania refiner, died suddenly December 2 at his home in Pittsburgh. Bannerot was president of United Refining Company and vice president of Elk Refining Company at Charleston, W. Va.

REPRINT POLICY

Due to increased printing and handling costs, PETROLEUM REFINER effective January 1, 1950, has instituted a new policy with regard to small, individual orders for reprints of its articles. Instead of supplying these free WHEN REPRINTS ARE AVAILABLE, a charge of 50 cents per copy will be made.

Cash or company requisitions should accompany all such "individual" orders.

This change does not affect the price for quantity orders (starting at 100 orders) which will be quoted at any time upon request.

This same 50-cent charge also applies to tear sheets of a particular article, tear sheets often being available when reprints are not.

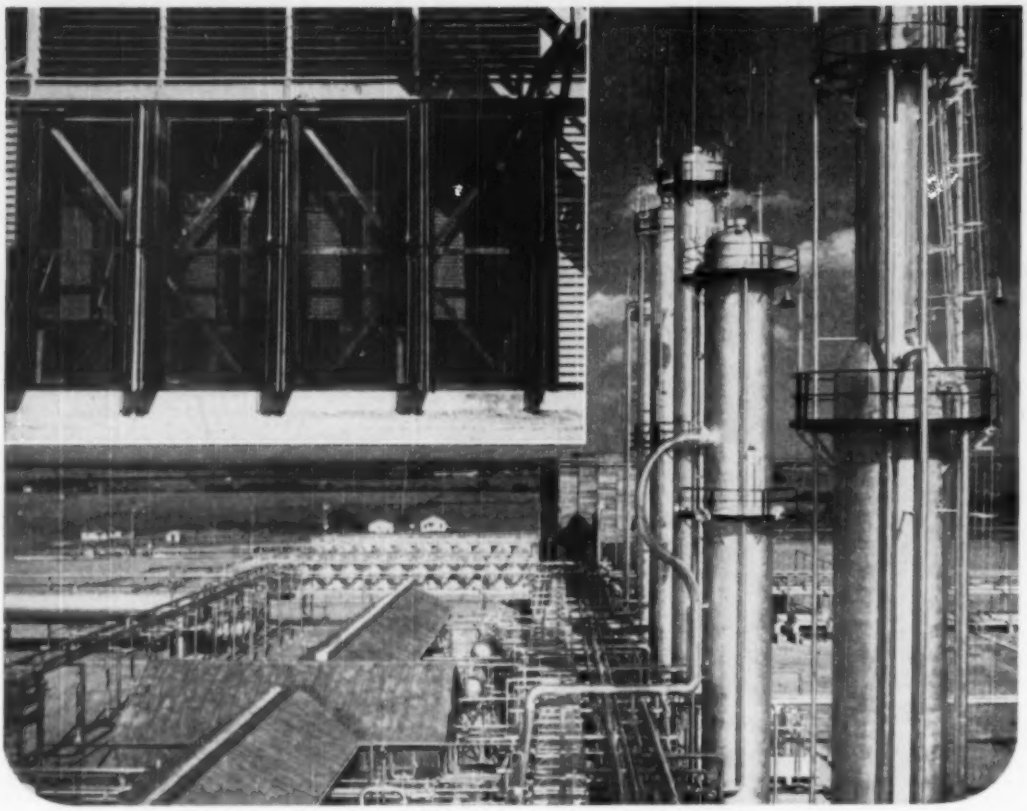
Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.

(All figures in thousands of barrels—add 000)

	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
Trends in Week Ended	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1948:									
January 31	5,318	5,434	228,083	15,986	102,973	7,690	37,733	9,141	35,510
February 28	5,387	5,463	226,980	15,796	111,040	7,963	30,689	8,934	34,742
March 27	5,377	5,324	229,409	15,763	112,961	7,682	27,483	8,854	33,463
April 24	5,415	5,517	228,488	16,515	111,128	6,831	30,808	8,877	34,437
May 29	5,452	5,715	228,979	17,327	107,185	7,654	34,662	9,508	39,089
June 26	5,494	5,674	229,632	17,038	104,178	7,300	41,137	8,858	42,558
July 31	5,455	5,718	230,720	17,646	99,116	6,822	52,439	9,080	48,618
August 28	5,529	5,682	229,873	17,722	95,304	7,491	61,814	8,818	52,544
September 25	5,343	5,356	234,158	16,705	94,910	7,536	71,426	8,380	57,745
October 30	5,504	5,626	230,702	17,560	91,925	7,879	77,114	8,853	60,845
November 27	5,617	5,721	244,346	17,317	90,902	7,476	80,375	9,477	63,960
December 25	5,641	5,784	250,555	18,178	100,286	7,776	74,576	9,121	63,374
1949:									
January 29	5,403	5,490	255,459	17,531	114,677	7,347	63,142	8,178	63,333
February 26	5,401	5,412	261,965	17,021	124,382	7,430	54,008	8,225	59,348
March 26	5,188	5,358	266,506	17,417	126,067	6,167	46,721	8,305	54,792
April 30	4,980	5,273	271,256	17,980	124,787	6,881	40,960	8,185	50,174
May 28	4,951	5,297	275,190	18,324	120,661	5,943	38,971	8,144	48,758
June 25	4,944	5,322	274,114	18,463	115,715	5,148	43,049	7,856	46,146
July 30	4,731	5,187	271,999	18,058	109,964	6,263	70,767	7,305	47,166
August 27	4,709	5,215	264,458	18,180	105,280	6,491	74,718	7,597	48,394
September 24	4,933	5,377	259,189	18,152	103,262	6,555	81,414	7,619	48,163
October 29	5,078	5,509	252,069	18,002	103,915	7,016	90,258	7,704	49,459
November 26	5,192	5,331	256,409	18,204	104,917	6,971	91,795	8,104	47,087
December 24	4,955	5,482	256,830	18,045	110,164	7,225	78,662	8,046	61,547

WESTERN'S VERTICAL SECTIONS



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SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

Chemical Composition and Reactions

General Introduction to Preparation of Hydrocarbons. M. M. JAMISON, M. S. LESSLIE, AND E. E. TURNER. *Jour. Inst. of Petroleum*, **35** (1949) pp. 590-620.

The paper is the first of three reports on past work of the Research Group of the Hydrocarbon Research Group of the Institute of Petroleum. It deals with the synthesis of hydrocarbons carried out in the period 1931-1944. The preparation of 70 hydrocarbons is described, including hexanes, heptanes, octanes, nomanes, cyclopentanes, cyclohexanes and numerous aromatic hydrocarbons. A bibliography of 121 references is included.

The Synthesis of Some Hydrocarbons. W. J. HICKINBOTTOM AND C. R. PORTER (with Florence Edwards, Elsa Schlüchterer, and F. Spitzer). *Jour. Inst. of Petroleum*, **35** (1949) 621-30.

The authors describe the preparation of hydrocarbons at the University of Birmingham as part of the work of the Hydrocarbon Research Group. The synthesis of 17 hydrocarbons is included, ranging from paraffins to the alkyl benzenes. A bibliography of 19 references is included.

Hydrocarbon Syntheses. By F. R. BUCK, B. B. ELSNER, T. HENSHALL, T. S. MOORE, A. R. MURRAY, S. H. MORRELL, G. MULLER, M. M. T. PLANT, J. C. SMITH, AND E. R. WALLSGROVE. *Jour. Inst. of Petroleum*, **35** (1949) pp. 631-68.

This paper completes the series of descriptions of hydrocarbons prepared in the period 1940-43 at Oxford, and covers a long list of heptanes, octanes, one nonane, several decanes and a number of cyclic compounds. A bibliography of 59 references is included.

Pyrolysis of Butadiene. MARY THOMAS MURPHY AND ANN CHARLES DUGGAN. *Jour. Am. Chem. Soc.*, **71**, (1949) pp. 3347-9.

In the pyrolysis of unsaturated hydrocarbons, it has been observed by the authors that the liquid products are frequently colored yellow. The first step in the present investigation was to pyrolyze large quantities of butadiene in order to isolate the yellow fraction in amounts large enough to analyze. In addition to previously reported products, cyclopentadiene, styrene, dimenthylfulvene, and a yellow hydrocarbon were identified. The presence of two higher boiling yellow fractions was indicated, but these have not yet been identified. The hydrocarbons obtained and their quantities per mol of butadiene are tabulated.

Oxidation of Hydrocarbons Catalyzed by Hydrogen Bromide. FREDERICK F. RUST, AND WILLIAM E. VAUGHAN. *Ind. Eng. Chem.*, **41** (1949) pp. 2595-2616.

The paper is a summary of work done by the Shell Development Company on the gas phase, homogeneous oxidation of the lower hydrocarbons. The oxidation is found to be greatly modified by the presence of hydrogen bromide. In the presence of this catalyst ethane is converted principally to acetic acid, straight-chain paraffins mainly to ketones, and branched-chain compounds chiefly to stable peroxides. The character of the product is determined largely by the most reactive carbon-hydrogen linkage in the molecule. In these reactions the reactivities of these linkages increase markedly in the order: primary, secondary, and tertiary. The introduction of oxygen under these conditions is accompanied by a low degree of carbon-carbon bond scission, the operating temperatures are low, and the conversion and yields are high. The summary paper is followed by four papers covering the oxidation of branched-chain compounds, straight-chain compounds, ethane and related compounds, and aromatic compounds.

Vapor-Phase Dehydration of Dodecanol Over Alumina. CHARLES A. WALKER. *Ind. Eng. Chem.*, **41** (1949) pp. 2640-4.

The dehydration of normal aliphatic primary alcohols over alumina in constant-pressure flow systems results in the formation of the corresponding olefin or ether or a mixture of the two. By suitable regulation of the temperature and flow rate it is possible to obtain the olefin as the main product. In general, this requires high temperature and low flow rate. The results on dehydrating 1-dodecanol at varying feed rates over alumina at pressures of 40, 160, and 320 mm. of mercury absolute and temperatures of 302, 318, 339, and 359° C. are reported. Conversions to olefin as high as 97 percent were obtained. The maximum conversion to ether that was obtained was 40 percent. The mechanism of alcohol dehydration is discussed. A bibliography of 14 references is included.

Chemistry of Cracking Catalysts. CHARLES L. THOMAS. *Ind. and Eng. Chemistry*, **41** (1949) pp. 2564-73.

The chemistry of silica and alumina in the solid state is applied to the silica-alumina cracking catalyst. This led to the belief that the active part of the catalyst is formed when one aluminum atom shares four oxygen atoms which in turn are shared by four silicon atoms. An acidic hydrogen ion is thought to be associated with the four oxygen atoms surrounding the aluminum atom. Catalytic activity is ascribed to this acidic hydrogen. The formula for the active part of the catalyst is written $(H_xAlSiO_4)_x$ where x indicates that it is part of a solid that may have the same or different composition. The monomer, $HAlSiO_4$ cannot exist. For maximum activity the catalyst should have a composition in which the atomic ratio of silica to alumina is one. To obtain maximum activity these catalysts should be made in special ways. Silica-alumina catalysts of maximum activity probably cannot be prepared by forming a silica hydrogel and depositing alumina on it. A bibliography of 32 references is included.

Catalytic and Thermal Cracking of Pure Hydrocarbons. Mechanisms of Reaction. B. S. GREENSFELDER, H. H. VOGE, AND G. M. GOOD. *Ind. Eng. Chem.*, **41** (1949) pp. 2573-84.

Primary cracking of pure hydrocarbons both with and without catalysts was studied in terms of the distribution by carbon number of the cracked fragments to allow determining the mechanism of molecular disintegration. The secondary reactions of the cracked fragments were also followed. On the basis of the work done, cracking systems are assigned to two fundamental classes, each described by a set of characteristic reactions covering both primary cracking and the secondary reactions. Correspondingly, two types of reaction mechanisms are proposed, one a free radical (thermal type) mechanism based on the Rice-Kossiakoff theory of cracking, and the other a carbonium ion (acid-activated type) mechanism derived from the work of Whitmore and others on the properties of carbonium ion systems. Cracking catalysts are available for either type of reaction mechanism; those that accelerate the free radical type reactions are non-acidic, and those that accelerate the carbonium ion type are acidic. Commercial acid-treated clay and synthetic silica-alumina cracking catalysts belong to the acidic class. Activated carbon, a highly active nonacidic catalyst, gives a unique product distribution which is explained as a quenched free radical type of cracking. Activated pure alumina has weakly acidic properties and produces moderate catalysis of

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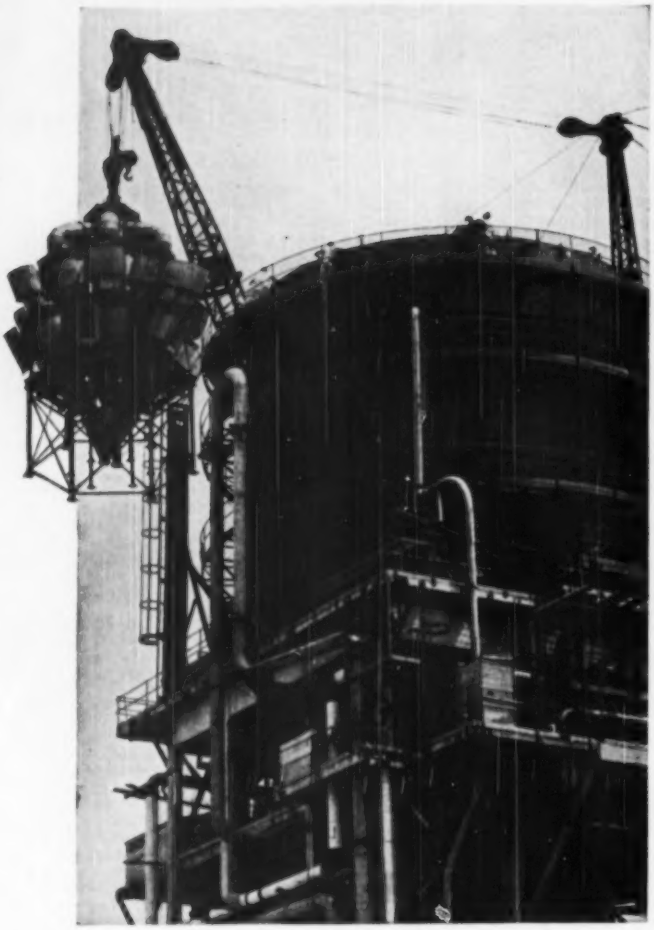

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both types of reaction mechanism, the primary cracking corresponding to a free radical mechanism and the secondary reactions of product orefins following a carbonium ion mechanism.

Manufacture: Processes and Plant

Heat Transfer and Pressure Drop in Heat Exchangers. DANIEL A. DONOHUE. *Ind. Eng. Chem.*, **41** (1949) pp. 2499-2511.

The purpose of the author was to study the available experimental data on heat transfer coefficient and pressure drop on the shell side of heat exchangers in order to present the underlying pattern that is revealed. A correlation of the coefficient of heat transfer in unbaffled shells was developed that differs considerably from the ones presently used. For any particular baffled shell the coefficient of heat transfer is expressed by the relation

$$\frac{hR}{k} = C\left(\frac{DG_e}{\mu}\right)^{0.6}\left(\frac{c\mu}{k}\right)^{0.33}\left(\frac{\mu}{\mu_0}\right)^{0.14}$$

in which G_e is the geometric mean of the mass velocities across the tube bundle and through the baffle opening. While G_e varies with baffle spacing and size of baffle opening, C accounts for all other shell-side structural characteristics, such as arrangement of tubes within the shell and leakage areas. Numerical values of C are found to be fairly constant for a given type of exchanger. Pressure drop data show that only partial flow penetration of the tube bundle occurs. The effect of this on heat transfer is considered. The interdependency of the coefficient of heat transfer and friction factor was studied. Higher coefficients of heat transfer were obtained with disk-and-doughnut baffles than with segmental baffles for the same values of fluid flow rate and pressure drop. The author presents the data and the results of the studies in detail in tabular and graphical form. A bibliography of 18 references is included.

Effect of Reduced Pressure on Efficiency of a Packed Rectification Column. LLOYD BERG AND D. O. POPOVAC. *Chem. Eng. Progress*, **45** (1949) pp. 683-91.

The investigators studied the effect of reducing the pressure on the efficiency of a packed rectification column. The test solution used was n-octane-toluene. Vapor-liquid equilibrium data were determined for this system at pressures of 20 mm. to 760 mm. of mercury. The column was tested at the same pressures at which the equilibrium data were taken and was operated just below the flooding point. Data were taken at total reflux and at reflux ratios 30:1 and 20:1. In each case it was found that the number of theoretical plates as determined from the corresponding vapor-liquid equilibrium diagram was between 11 and 14. The same column calibrated 14 plates at atmospheric pressure with the standard test mixture n-heptane-toluene. The authors state that the results indicate that column efficiency is independent of pressure. Design calculations can be based on vapor-liquid equilibrium data determined at the same

pressure as that at which the column is to operate, the H.E.T.P. of a given packing remaining constant.

In the discussion that followed the presentation of the paper there was considerable disagreement and it was contended that column efficiency varies with working pressure.

Alkylation of Isobutane with Propylene Commercial Production Using Sulfuric Acid Catalyst. E. CLARENCE ODEN AND W. J. BURCH, JR. *Ind. Eng Chem.*, **41** (1949) pp. 2524-30.

Propylene has not been utilized extensively for alkylation of isobutane because of the high catalyst consumption, as compared with butylene or amylene as a feed stock and because the propetrties of propylene alkylate are somewhat inferior. However those refineries having large alkylation capacity, large sources of propylene, and cheap sources for production and regeneration of sulfuric acid are in good position to alkylate isobutane with propylene on a commercial scale. In the work reported a depropanizer overhead cut produced on a catalytic cracking recovery unit with rates as high as 4500 barrels per stream day, and varying in composition from 45 to 60 percent propylene, along with propane and small quantities of butanes, ethane, ethylene, and methane, was charged along with isobutane and other streams containing butylenes to an alkylation unit. The olefin feed varied in composition from 0 to 100 percent propylente and 100 to 0 percent butylene and/or dimer. The alkylation was conducted in the horizontal jet-type reactor-settlers with sulfuric acid as catalyst. Yields ranged from 2000 to 6000 barrels per day of light alkylate. Information is given on the variables affecting octane quality and acid consumption together with data needed for process design. Typical distillation and combining ratio data for various types of alkylate produced are also presented. As propylene in the olefin feed increased, the octane number of the light alkylate decreased, the distillation range of the product decreased, the percentage of C_8 and C_6 fractions increased, the isobutane to olefin combining ratio increased, the total alkylate to olefin combining-ratio increased, and acid consumption increased. As the reactor-settler temperature increased the quality of the alkylate decreased. As the spent acid concentration increased from 89 to 95 percent, no change in the octane quality of the product was shown. As the external-isobutane-to-olefin ratio increased, the octane rating increased, and the alkylate-to-olefin ratio increased, over the range studied.

Effect of Reactor Temperature on Product Distribution and Product Quality in Fluid Catalytic Cracking. C. R. OLSEN AND M. J. STERBA. *Chem. Eng. Progress*, **45** (1949) pp. 692-700.

Pilot plant tests were made at three reactor temperature levels: 800, 900 and 950° F., using a synthetic catalyst. The runs were made once through and the conversions at each temperature level varied from approximately 45 to 75 volume percent of gas oil charge disappearance. Product distribution and

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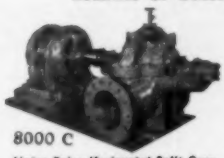

8000 C

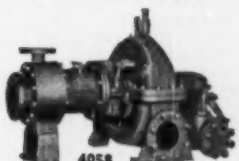
Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump


4058

Turbine Drive Close Coupled Centrifugal Pump

942

Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump

3833

Horizontal Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump

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quality are shown graphically for the three temperatures, and cross plots have been prepared showing the effect of temperature on product distribution at a conversion level of 60 percent. Product distribution among individual light hydrocarbons through the C_6 fraction is shown, the C_6 fraction was split into olefins and paraffins, and the dependanized gasoline was resolved into three groups of hydrocarbon types. The general effect of increasing reactor temperature at a given conversion is to cause less deposit on the catalyst, less debutanized gasoline, and greater amounts of light hydrocarbon fraction having higher olefin content. The liquid products contain higher concentrations of unsaturated components, and the clear octane number of the gasoline is increased.

Synthesis Gas Production. Reaction of Light Hydrocarbons, Steam, and Carbon Dioxide in Commercial Equipment. E. C. Clark, R. H. Kallenberger, R. Y. Browne, and J. R. Phillips. *Chem. Eng. Progress*, **45** (1949) pp. 651-4.

The production of synthesis gas suitable for the Fischer-Tropsch synthesis in a commercial-scale plant is described. Mixtures of hydrogen and carbon monoxide containing 33 to 90 percent carbon monoxide were produced by the reaction of natural gas with steam and carbon dioxide. The authors conclude that the reforming of light hydrocarbons is feasible for the production of gas suitable for hydrocarbon synthesis, that the gas composition can be varied within wide limits by varying the reactant bed and that the process is easily controlled and operated.

Ethane Pyrolysis. H. J. Hepp, F. P. Spessard, and J. H. Randall. *Ind. Eng. Chem.*, **41** (1949) pp. 2531-35.

Propane has been a preferred charging stock for ethylene manufacture because relatively low temperatures are required for its cracking and per-pass yields are high. However the price of propane has increased to a point when in many cases it is more economical to use other feed stock. Ethane is a particularly attractive feed stock for ethylene manufacture. In the investigation reported ethane was cracked in a copper-lined, alloy steel tube at temperatures in the range 1700 to 1900 degrees F. Principal products were hydrogen and ethylene, but acetylene and butadiene were also formed in appreciable quantities. The concentration of ethylene in the cracked gas increased with increased ethane cracking to a maximum value of 37 percent at 1800° F. and with 83 percent destruction of the ethane. Acetylene concentration also increased with increased ethane destruction, the percentage in the cracked gas reaching 3.4 percent under the most drastic cracking conditions. Butadiene reached a steady-state value of approximately 1 percent of the cracked gas. Yields of hydrogen, methane, and ethylene plus acetylene are correlated with the temperature, pressure, and reaction time variables on the basis of the equilibrium dissociation of ethane. First-order reaction velocity constants, calculated from the data, lie on an extrapolation of the plot of the Steacie and Shane ethane rate equation. The apparatus used in the work is described and the data are presented in detail in tabular and graphical form. A bibliography of 17 references is included.

Phase State and Thermal Transitions of Greases. M. J. Vold, G. S. Hattiangdi, and R. D. Vold. *Ind Eng. Chem.*, **41** (1949) pp. 2539-46.

The authors present results of a study of the X-ray diffraction patterns and differential heating curves of samples of different types of commercial greases and of oil-free soaps of similar composition. The purpose of the work was to determine to what extent greases of different types exhibit comparable behavior, whether there is any evidence that greases are other than mechanical dispersions of soap in oil at room temperature, whether the crystal structure of the soap is affected by its in situ formation in oil during grease manufacture in contrast with its preparation by precipitation from oil-free aqueous media, what type of solubility relations exist at temperatures above room temperature, and whether or not these are simply related to the thermal transitions of the oil-free soap? Diffraction patterns and differential heating curves were obtained for aluminum, barium, calcium, lithium, sodium, and mixed base commercial lubricating greases and for the corresponding oil-free soaps. At room temperature the greases contain principally finely divided crystalline soap in oil, but the crystallites may be modified by in situ formation as compared with their structure when prepared in the oil-free state. The nature and extent of these effects vary with the soap cation and with the incorporation of additives. Lithium soap crystallites are almost unaffected by in situ formation except in size, while at the other extreme, greases stabilized with barium acetate contain crystallites of structure entirely different from either that of soap or salt. On being heated, the greases undergo a thermal transformation that is in some cases closely related to the polymorphic transformations of the oil-free soaps. In other cases there exist more complex solubility relations involving swelling of the soap to form liquid crystalline solutions of oil in soap. A bibliography of 24 references is included.

Fundamental Physical and Chemical Data

Thermal Data on Organic Compounds. XXV. Some Heat Capacity, Entropy and Free Energy Data for Nine Hydrocarbons of High Molecular Weight. George S. Parks, George E. Moore, Melvin L. Renquist, Benjamin F. Naylor, Leslie A. McClaine, Paul S. Fujii and John A. Hatton. *Jour. Am. Chem. Soc.* **71** (1949) pp. 3386-9.

The specific heats of nine hydrocarbons of high molecular weight were measured between 78 and 300° K. These included hexadecane, octadecane, tetracosane, dotriacontane, ethylcyclohexane, n-heptyl-cyclohexane, n-dodecylcyclohexane, 11-cyclohexylheneicosane, 11-phenylheneicosane. The heats of fusion of seven of the hydrocarbons were determined. Entropies in the liquid or crystalline states at 298.16° K. were calculated from the heat capacity data. Corresponding molal free energies were also calculated. Values of 1.21 kcal. and 12.8 kcal. were determined for the respective contributions of a CH_2 group and a cyclohexyl group in the liquid straight-chain compounds. The data are presented in tabular form.

Compressibility and Critical Constants of Propylene Vapor. Henry Marchman, H. William Prengle, Jr., and R. L. Motard. *Ind. Eng. Chem.*, **41** (1949) pp. 2658-60.

Compressibilities of propylene vapor are presented from 10 to 215 atmospheres and from 30° to 250° C. The critical properties, vapor pressure, and saturated vapor volumes are also given. The constants for the Benedict-Webb-Rubin equation of state are reported and correlate the data up to a density of 9.0 moles per liter with an over-all average deviation of only 0.20 percent. Data are presented in detail in tabular and graphical form and a bibliography of ten references is included.

The Density and Transition Points of Solid Hexamethylethane. Wm. F. Sever, R. B. Bennett and F. C. Williams. *Jour. Am. Chem. Soc.*, **71** (1949) pp. 3447-51.

Numerous studies have been made of the various solid phases of the n-paraffin hydrocarbons, and as a result considerable knowledge has accumulated concerning their crystal structure, transition points and latent heats. In contrast, knowledge of the branched chain hydrocarbons is exceedingly small. Few have been prepared as pure compounds. In the present work the density of hexamethylethane was measured over the temperature range 20-103.5° C. Two transition points were obtained upon cooling the liquid, one at 99.65° and the other at 74.25°. The existence of two forms of the hydrocarbon can be explained in a similar manner as that of the normal paraffins, except that in this instance the stable form has a cubic structure with the molecule standing upright in the 001 plane instead of being tilted as are the long chain hydrocarbons.

Latent Heats of Vaporization. Simplified Method for Cauculating Engineering Data. V. A. Klein. *Chem. Eng. Progress*, **45** (1949) pp. 675-6.

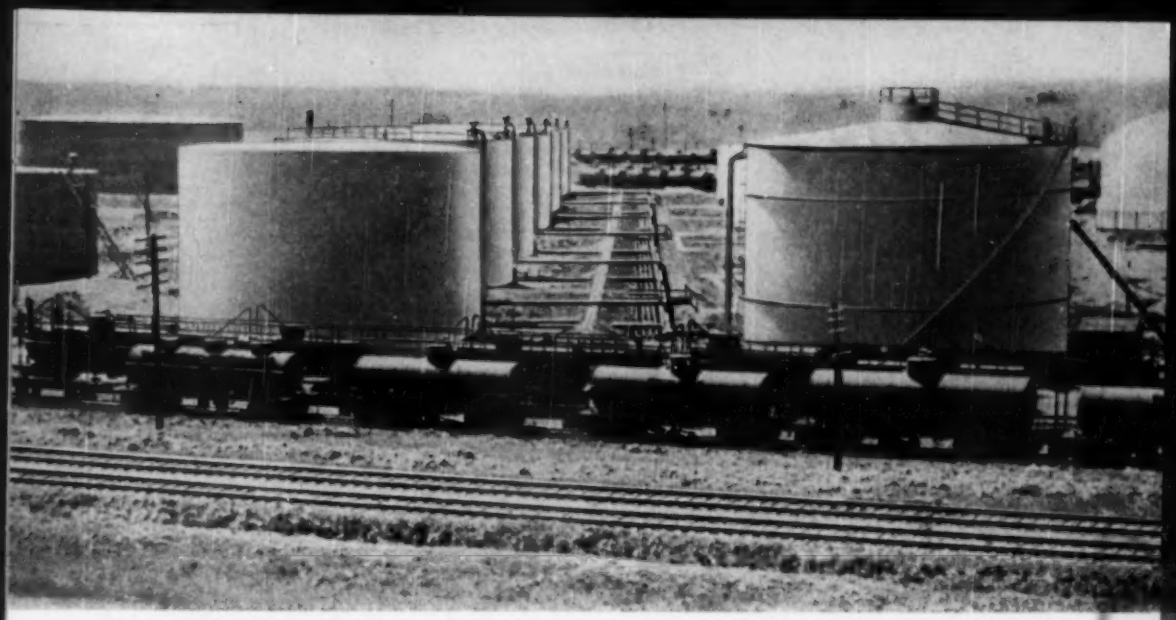
The author presents an equation from which latent heats of vaporization sufficiently accurate for most engineering purposes can be calculated from limited data. The data required are the normal boiling point, or one vapor pressure measurement and the critical temperature and pressure, which may be estimated if experimental values are unavailable. The equation is

$$\Delta H_v = \frac{RT}{T_c - 1}\sqrt{1 - \frac{P_r}{T_r 3}}\ln P_c$$

A table giving the results of typical calculations compared with experimental data is presented.

Products: Properties, Utilization and Analysis

Corrosion-Inhibited Fuels. Josef M. Michel and Karl F. Hager. *Ind. Eng.*



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Science and Technology

Chem., **41** (1949) pp. 2616-22.

The authors present a survey of known methods and recent advances in the field of corrosion prevention in pipe lines, storage containers, tanks, and other equipment in contact with fuels. They conclude that of all methods of corrosion prevention, only that involving admixtures to the fuel in order to produce passivity promises an extended technical application. Work starting in the 1930's finally led to the surprising result that, without regard to the construction materials used, even a small addition of Mepasin-sulfamido-acetic acid-sodium salt to the fuel prevents any corrosion. Mepasin refers to a certain fraction of hydrocarbons gained by the Fischer-Tropsch synthesis, chain length about 12 to 18 carbon atoms. The results present a prospect of solving many corrosion problems, starting at the oil well and ending with the last fuel consumer, by the simple addition of the smallest amount of such chemicals.

Calculating the Performance of Motor Fuel Blends. J. S. Bogen and R. M. Nichols. *Ind. Eng. Chem.*, **41** (1949) pp. 2629-35.

A method and substantiating data are presented for estimating the performance characteristics of multicomponent motor fuel blends. The work was limited to the four major components of motor fuel: straight-run, thermally cracked, polymer, and catalytically cracked gasolines. Multicomponent blends that covered practical commercial concentrations were made and rated by F-1, F-2, and F-8B methods, clear and with 1 and 3 ml. tetraethyllead per gallon. A series of curves was obtained from which it is possible to estimate the performance characteristics of multicomponent motor fuel blends. Work still to be done will include stocks from other crude sources.

Synthetic Gasoline from Natural Gas. F. H. Bruner. *Ind. Eng. Chem.*, **41** (1949) pp. 2511-5.

The purpose of the paper is to present information on the hydrocarbon distribution in synthetic gasoline of the type to be made by the Hydrocol Process. Such gasolines have been made entirely in pilot plant work, but it is believed that the quality of the product will be similar to that soon to be produced in a commercial unit. Gasoline produced in this country by the fluidized iron-catalyzed hydrogenation of carbon monoxide is of much higher quality than that commercially produced in Europe by the Fischer-Tropsch fixed-bed, cobalt-catalyzed process. The European process gives rise to a paraffinic material, while the process used in this country gives relatively low boiling and highly olefinic hydrocarbons. The olefins are largely straight chain or monomethyl with the double bond in the 1-position. This fact permits conversion of the gasoline to a high octane fuel or blending stock by a simple catalytic treatment. A 7-pound Reid vapor pressure, 400° F. end point naphtha has an A.S.T.M. D-357 motor octane of 82. The synthetic fuels are found to blend normally with straight-run and cracked products from other sources.

Hydrocarbon Type Analysis. Estima-

tion of Six-Membered Ring Naphthenes. H. C. RAMPTON. *Analytical Chem.*, **21** (1949) 1377-83.

A method of hydrocarbon type analysis of petroleum naphthas is described, which is based on examination of cuts of specified boiling ranges prepared by fractionation of original and dearomatized samples. The main object of the method is the estimation of the five- and six-membered ring naphthenes throughout the range initial boiling point to 225° C. Cut points selected insure the segregation of particular groups of hydrocarbons. The "reactable" six-membered ring naphthene contents are determined by the dehydrogenation procedure and do not embrace geminal cyclohexane derivatives. These latter are included in the "unreactable" naphthene content, together with the cyclopentane derivatives. A bibliography of 13 references is included.

Spectroscopic Analysis of Isomeric Xylene Mixtures. RAYMOND T. VAUGHN AND ALLEN E. STEARN. *Analytical Chem.*, **21** (1949) pp. 1361-3.

An ultraviolet spectroscopic method for the analysis of mixtures with overlapping absorption bands is described. The method is applied to isomeric xylene mixtures as an example. A working chart was prepared from the difference in measured optical densities at selected wave lengths and the known composition of the samples. From ultraviolet absorption measurements at four wave lengths the composition of isomeric xylene mixtures can then be read from the chart. The deviations from known compositions were found to be less than 1 percent. The method is rapid and does not require measurement of extinction coefficients or solvent and cell corrections. Departure from Beer's law does not affect the accuracy of the results.

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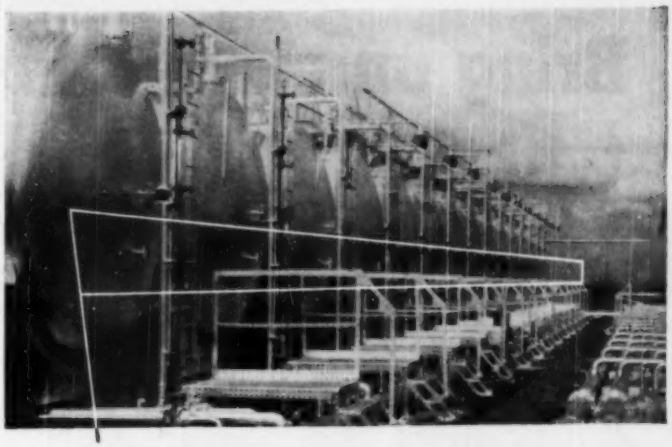
1,7-Dichloroheptane
2,6-Difluoro-p-xylene
2-Methylcrotonic acid
2-Phenyl-1,3-indanedione
Ethyl sulfinic acid
1,3-Butylene oxide
2-Chlorocyclohexanone
2-Methyladipic acid
1,2-Dichlorooctadecane
2,3-Dimethylmaleic anhydride
Homoterephthalic acid
Methylene sulfate
9-Hendecenoic acid
Cyclohexylcyclopentane
3,3-Dimethylglutaric acid



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Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, October 18, 25 and November 1, 8, 1949)

REFINING

U.S.P. 2,484,834. Method of Refining Light Oil Products. W. O. Kelling to Koppers Company, Inc.

Impure benzene is mixed with a solvent for both the benzene and the impurities. The mixture is chilled while stirring to crystallize a major portion of the benzene in fine grained crystals which are separated and melted. The benzene is then distilled to recover purified benzene. The mother liquor of the separated crystals is mixed with a benzene azeotrope solvent, and the mixture is distilled to separate a benzene azeotrope from impurities.

U.S.P. 2,485,070-1. Inhibiting Polymerization of Furfural in Extractive Distillation. W. A. Schulze and J. C. Hillyer to Phillips Petroleum Company.

A hydrocarbon mixture containing unsaturates selectively soluble in furfural is extractively distilled at at least 200° F. under non-oxidizing conditions with furfural containing not more than 1 percent (by weight) of pyridine or its alkyl homologues as furfural polymerization inhibiting compound. According to U.S.P. 2,485,071, an alkali metal thiocyanate is employed as the polymerization inhibitor.

U.S.P. 2,485,265. Process for the Separation of Triisobutylene Isomers. L. T. Eby to Standard Oil Development Company.

The isomers of triisobutylene with a double bond attached to the second carbon atom in the longest chain are separated from the isomers of triisobutylene with a double bond attached to the fourth C atom in the longest chain by the addition of HCl to the mixture of the isomers. The HCl reacts with the first named type of isomer. The reaction mixture is distilled to separate unreacted isomers, whereupon the triisobutylene chlorides are dehydrochlorinated.

U.S.P. 2,485,297. Hydrocarbon Emulsion. C. J. G. Lessemann to Standard Oil Development Company.

A stable aqueous emulsion of gasoline hydrocarbons is obtained by the use of a mixture of a major amount of a saturated aqueous solution of a hydroxy benzoic acid and a minor amount of acetone or methyl ethyl ketone.

U.S.P. 2,485,298. Method for Breaking Emulsion. C. J. G. Lessemann to Standard Oil Development Company.

For breaking an emulsion of the type obtained according to U.S.P. 2,485,297, the concentration of the ketone in the admixture to the gasoline hydrocarbon is adjusted in excess of 30 percent by volume of this admixture. A hydrocarbon and an aqueous phase are formed.

U.S.P. 2,485,696. Motor Fuel. J. A. Chenicek to Universal Oil Products Company.

To gasoline contaminated with an iron impurity is added 0.001-0.1 percent by weight of an aminophenol oxidation inhibitor and 0.001-1 percent of an o-nitroso-phenol or -naphthol or di-nitroso-resorcinol. The deleterious effect of the iron contaminants is inhibited by the additives.

U.S.P 2,485,897. Superfuel. R. F. Marschner to Standard Oil Company (Indiana.)

A motor fuel for a high compression internal combustion, spark ignition engine essentially consists of a mixture of triptane and cyclopentane, each of which is present in the mixture to the extent of at least 25 percent by volume. The IMEP (indicated mean effective pressure) of this superfuel is substantially greater than that of either component of the mixture.

U.S.P. 2,485,964. Methylcyclopentene Production. G. M. Good and H. H. Voge to Shell Development Company.

Details are claimed of a process for the production of relatively pure methylcyclopentenes from complex hydrocarbon mixtures containing 1, 3, and 4-methylcyclopentene in mixture with close boiling open chain, aliphatic hydrocarbons with 6-7 C atoms by fractionl distillation with intermediate isomerization of certain fractions.

U.S.P. 2,485,965. Cyclohexene Production. H. H. Voge and G. M. Good to Shell Development Company.

The process according to this patent is related to that of U.S.P 2,485,964. It is concerned with the production of relatively pure cyclohexene from a hydrocarbon fraction consisting of methylcyclopentane in admixture with close boiling, open chain hydrocarbons, the methylcyclopentene fraction being first subjected to dehydrogenation to form methylcyclopentene which is later isomerized to cyclohexene.

U.S.P. 2,485,966. Methylcyclopentene Production. G. M. Good and H. H. Voge to Shell Development Company.

The purpose of the process is similar to that of U.S.P. 2,485,964. A selectively reacting chemical agent is employed here for reacting with 1-methylcyclopentene. Tertiary cyclic olefins are recovered.

U.S.P. 2,486,538. Metal Deactivator and a Gasoline Fuel Containing the Same. R. B. Thompson to Universal Oil Products Company.

Olefinic gasoline is stablized against oxidative deterioration in the presence of metals by the addition of a mixture of 2-salicylal-aminophenol and 2-salicyl-alamino-alkyl-phenol as a metal deactivator.

U.S.P. 2,486,543. Treatment of Normally Gaseous Hydrocarbons. H. H. Wenzke to Universal Oil Products Company.

Ethylene is separated from a gaseous hydrocarbon mixture also containing gases lighter and heavier than ethylene by a process claimed in detail and employing a liquid ethylene absorbent.

U.S.P. 2,486,929. Azeotropic Distillation of Methyl Acetylene from Butadiene. M. R. Dean to Phillips Petroleum Company.

Butadiene is freed from accompanying methyl acetylene by fractional distillation in the presence of an aliphatic C_4 hydrocarbon more saturated and lower boiling than butadiene. The mol ratio of this C_4 hydrocarbon to the methyl acetylene shall be at least 1:1. The overhead fraction contains the methyl acetylene and the additive.

U.S.P. 2,487,103. Production of Fuel Oils From Acid Sludge. J. H. Cone and R. V. Comeaux to Standard Oil Development Company.

Acid sludge obtained in the treatment of petroleum with H_2SO_4 is hydrolized at a temperature of 100-200° F. An acid-oil layer formed is separated from an acid layer. The acid-oil layer is treated with a brine of an alkali metal halide. The separated acid oil is neutralized with NaOH-solution and fuel oil is obtained.

U.S.P. 2,487,142. Treatment of Hydrocarbons. C. S. Kelley to Phillips Petroleum Company.

A mixture of propane and lighter hydrocarbons, H_2S and HF is contacted in the liquid phase with a solution of sodium bisulfide. The HF is selectively absorbed and the mixture is thus freed from HF.

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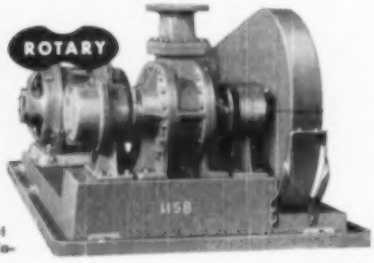

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Patents

U.S.P. 2,487,147. Fractionating Methane and Ethane from Hydrocarbon Mixtures. J. W. Latchum, Jr., to Phillips Petroleum Company.

Dissolved methane and ethane are fractionated from a volatile hydrocarbon mixture at a higher pressure and a lower reboiler temperature than normally required. Details of the process are claimed.

U.S.P. 2,487,184. Butadiene Purification. W. H. Rupp to Standard Oil Development Company.

A liquid mixture containing a diolefin, such as butadiene, and higher boiling contaminants and explosive acetylene compounds, as obtained by extraction of a hydrocarbon mixture with a copper salt solution, is treated by circulating and heating a water stream removed from the mixture. The water stream, free of oxygen, is mixed with the mixture of diolefin and contaminants at a temperature sufficient to vaporize the diolefin which is thus purified.

U.S.P. 2,487,189-90. Diesel Fuel Oils. H. G. Smith, T. L. Cantrell, and M. L. Hill to Gulf Oil Corporation.

Diesel oil is compounded with 0.01-0.25 percent by weight of the product obtained by neutralizing the mixture of fatty acids and alcohols contained in hydrolyzed sperm oil with a long-chain primary aliphatic amine having at least 10 C. atoms. According to U.S.P. 2,487,-190, a partially hydrolyzed sulfurized sperm oil is used in the neutralized mixture.

CATALYST PREPARATION, ACTIVATION, AND REGENERATION

U.S.P. 2,484,828. Production of Contact Materials. J. H. Hickey to Great Lakes Carbon Corporation.

Details are claimed of a process for producing a catalytically active material from bentonite clay by acid treatment.

U.S.P. 2,485,050. Recovery of Metal Halides. H. J. Hepp and H. R. Sailors to Phillips Petroleum Company.

Details of a process are claimed for the recovery of metal halide from a liquid hydrocarbon-metal halide complex by destructive distillation while continuously grinding solid decomposition products formed therein.

U.S.P. 2,485,249. Process and Apparatus for Manufacturing Gels. H. M. Weir to Davison Chemical Corporation.

Hydrogels, e.g. silica hydrogel, are formed within an elongated gelling zone of special construction by a process claimed in detail.

U.S.P. 2,485,260. Hydrocarbon Conversion in Presence of Silica-Magnesia Catalyst. G. C. Connolly to Standard Oil Development Company.

Hydrocarbon oils are contacted at conversion temperatures with a catalyst consisting of 15-30 percent of active magnesia and of active silica. The catalyst is prepared by intimately mixing finely divided magnesia with silica hydrogel, drying, and igniting the mixture.

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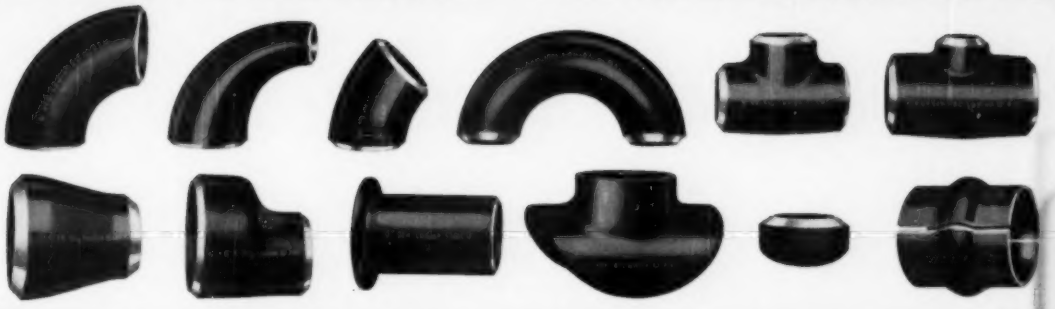

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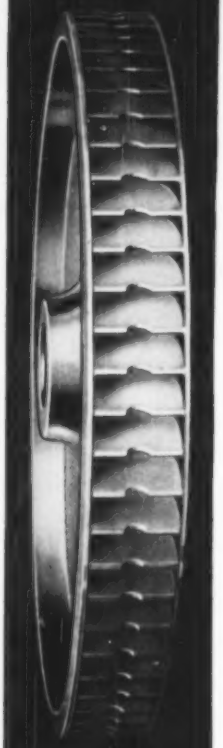

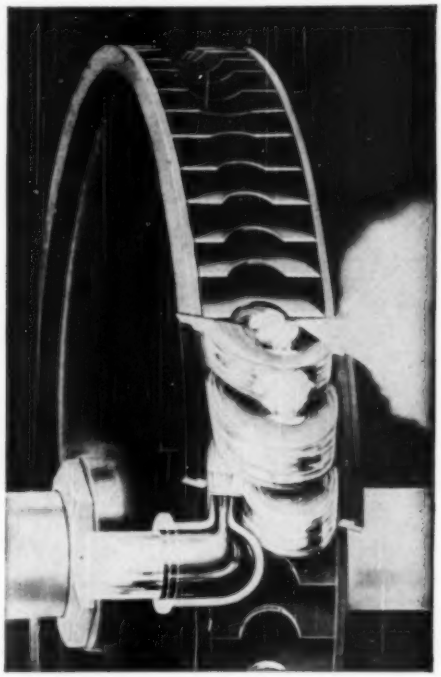

Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

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T-1172

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Patents

U.S.P. 2,485,697. Preparation of Arsenic Trichloride. J. A. Chenicek to Universal Oil Products Company.

An aluminum chloride-hydrocarbon complex is reacted with As_2O_3 to form $AsCl_3$ and Al_2O_3. Hydrocarbons liberated by the reaction are separately removed.

U.S.P. 2,486,368. HF-BF_3-H_2O Isomerization Catlyst. F. E. Frey to Phillips Petroleum Company.

A catalyst for the isomerization of hydrocarbons consists of the product resulting from admixing liquid HF, 0.1-10 percent by weight of BF_3 in excess of that molecularly equivalent to the water present, and water in an amount of 0.05-1.0 percent and less than that molecularly equivalent to the BF_3 present.

U.S.P. 2,486,484. Treatment of Metal Halide Sludge. J. W. Latchum, Jr., to Phillips Petroleum Company.

Spent Friedel-Crafts type metal halide-organic sludge from hydrocarbon conversion reactions is contacted with a strong, relatively non-volatile mineral acid, e.g. H_2SO_4 or H_3PO_4. The resulting hydrogen halide and the resulting metal salt of said non-volatile acid are recovered. The metal salt is reacted with water and an alkali or alkaline earth metal halide and the hydrogen halide thus formed is also recovered.

U.S.P. 2,486,485. Utilization of Metal Halide-Hydrocarbon Sludge. J. W. Latchum, Jr., to Philips Petroleum Company.

Spent Friedel-Crafts type metal halide-hydrocarbon sludge is first treated with a strong mineral acid in the manner described in U.S.P. 2,486,484 with separation of the hydrogen halide formed. The remaining reaction mixture is hydrolyzed by treatment with water to form alcohols. The effluent of this reaction is allowed to settle. A non-aqueous layer containing the alcohols, and an aqueous layer containing the salt of the strong mineral acid are formed. The alcohols, the salt, and the excess of the strong mineral acid are recovered.

U.S.P. 2,487,065. Preparation of Gel Catalysts. T. H. Milliken, Jr. to Houdry Process Corporation.

A powder of a size less than 50 microns is incorporated in a sol. The powder shall be infusible at the temperatures at which the catalyst in preparation is to be employed and is insoluble in the sol. The sol is allowed to set to a hydrogel which is dried in discrete pieces. The amount of powder present shall be such that the vol. ratio of powder to gel is between 0.35 and 1. Rapid drying of the hydrogel pieces without breakage is permitted by the admixture of the powder.

U.S.P. 2,487,159. Regeneration of Iron Type Hydrocarbon Synthesis Catalyst. D. R. McAdams and M. A. Segura to Standard Oil Development Company.

Fluidized, finely divided spent iron type synthesis catalyst is steamed at a temperature of 600-1200° F. The resultant material is heated under oxidizing conditions at a temperature of 700-1000° F. The thus treated mass which still retains its fluidization characteristics is immediately employed again as synthesis catalyst.

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Patents

U.S.P. 2,487,563. Catalyst for Hydrocarbon Conversion Process. E. T. Layng to The M. W. Kellogg Company.

Hydrocarbons are converted by contact at elevated temperature with a catalyst comprising a synthetic mixture of alumina, silica, iron oxide, and an oxide of a metal of the left-hand columns of the periodic Groups IV, V, and VI.

U.S.P. 2,487,564. Silica Gel-Alumina Supported Catalyst. E. T. Layng to The M. W. Kellogg Company.

A hydrocarbon conversion catalyst consists of 1-12 percent of a metal of the left-hand columns of the periodic Group V and VI, such as MoO_3, and a carrier consisting of alumina and silica gel in such proportions that the silica constitutes 1-15 percent of the catalyst composition.

U.S.P. 2,487,717. Apparatus for Controlling Catalyst Regeneration. F. L. Maker and W. J. McLeod to California Research Corporation.

Details of an apparatus are claimed for effecting changes in organic fluids, such as a circulating gas stream containing oxygen and used in the regeneration of solid catalysts. The concentration of the oxygen or other reagent in the circulating fluid stream can be maintained at a certain level by means of this apparatus.

CRACKING AND REFORMING

U.S.P. 2,485,318. Method and Apparatus for Contacting Solids and Gases. W. F. Rollman to Standard Oil Development Company.

Details are claimed of a method for effecting vapor phase reactions in the presence of a granular solid material, e.g. for the continuous cracking of hydrocarbons. The highly heated solid material is conducted downwardly in the reaction zone countercurrent to the gasiform charge material preheated to a temperature below that of the reaction.

U.S.P. 2,485,626. Catalytic Conversion of Hydrocarbons. G. A. Mills to Houdry Process Corporation.

Hydrocarbon oil is cracked in the presence of a catalyst comprising a kaolin clay activated by calcination at temperatures above 800° F. followed by leaching with acid. Gasoline is obtained.

U.S.P. 2,487,132. Contacting Gaseous Fluid with Solid Particles. C. E. Hemminger to Standard Oil Development Company.

Details are claimed of a process for treating (e.g. cracking) hydrocarbons with a fluidized subdivided solid material with stripping of the spent solid material in a particular manner.

U.S.P. 2,487,324. Conversion of Hydrocarbons. G. J. Forseth to Phillips Petroleum Company.

Details are claimed of a process for converting heavier hydrocarbon material into gasoline hydrocarbons by cracking or reforming with a minimum pro-

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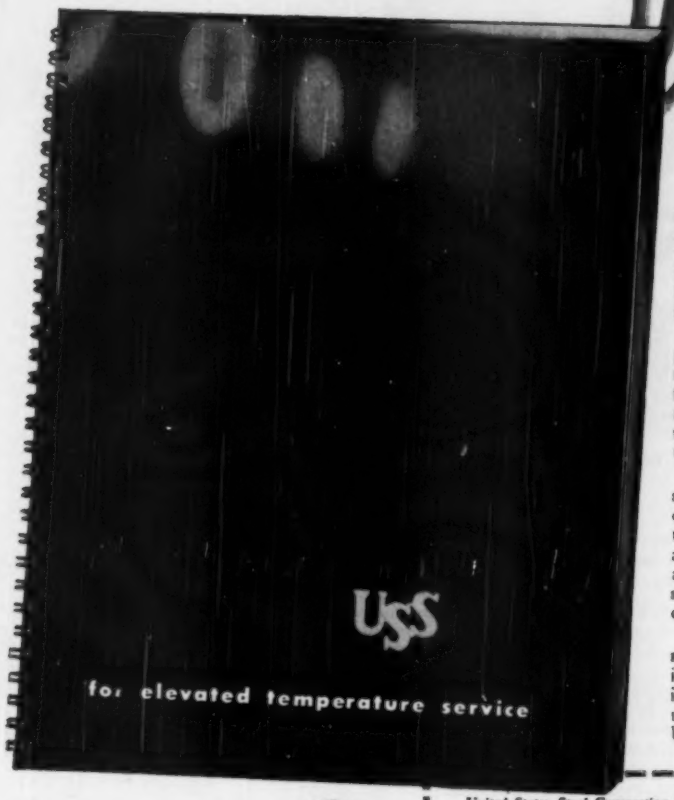

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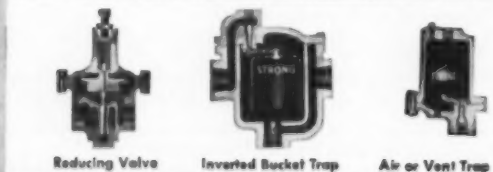

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Patents

duction of solid carbonaceous material. A fixed bed of granular bauxite is employed as cracking catalyst.

POLYMERIZATION AND CONVERSION

U.S.P. 2,485,273. Copolymer of Butadiene-1,3 and Alpha Methyl Para Methyl Styrene. P. K. Frolich and E. Arundale to Standard Oil Development Company.

An aqueous emulsion of 26 parts by weight of p-methyl alpha-methyl styrene and 74 parts of butadiene-1,3 is copolymerized. A rubber-like material is produced.

U.S.P. 2,485,276. Method for Inhibiting Corrosion Caused by Liquid Aluminum Halide Catalysts. O. Gerbes to Standard Oil Development Company.

In the catalytic conversion of hydrocarbons by use of an electrically conductive organic complex of aluminum halide, hydrogen halide, and a hydrocarbon in a ferrous metal reaction vessel, a direct electric current of a certain density is passed through the complex to the walls of the reaction vessel forming the cathode. Corrosion of the reaction vessel by the complex is inhibited.

U.S.P. 2,485,335. Polymer Separation. C. W. Tyson to Standard Oil Development Company.

High molecular weight rubbery polymers are produced by copolymerization of 90-99 percent by weight of isobutylene and 10-1 percent of isoprene at a temperature of —70° to —100° C. in the presence of 60-90 percent of the total reaction liquid of methyl chloride and in the presence of a dissolved Friedel-Crafts catalyst. Details of this process are claimed.

U.S.P. 2,485,454. Low-Temperature Catalytic Process for Polymerizing Olefinic Materials in the Presence of an Inorganic Diluent. J. F. Nelson and W. J. Sparks to Standard Oil Development Company.

The process of this patent is related to that of U.S.P. 2,485,335. The polymerization temperature is —20° to —100° C. The reaction components are mixed with liquid nitrous oxide. The cooled mixture is then admixed with a solution of a Friedel-Crafts catalyst dissolved in an alkyl halide.

U.S.P. 2,485,535. Ceric Sulfate Catalyzed Emulsion Polymerization of Styrene. H. F. Park to Monsanto Chemical Company.

Styrene is emulsion polymerized at a temperature of 60-100° C. in contact with 0.01-0.4 part of ceris sulfate per 100 parts of styrene.

U.S.P. 2,485,616. Emulsion Polymerization of Butadiene in the Presence of a Salt of a Middle Fraction of a Dehydrogenated Rosin. J. H. Long and D. H. Sheffield to Hercules Powder Company.

Conjugated butadiene alone or in mixture with styrene is emulsion polymerized in the presence of an emulsifier, e.g. 1-5 percent of an alkali metal salt of a middle fraction of a fractional dehydro-

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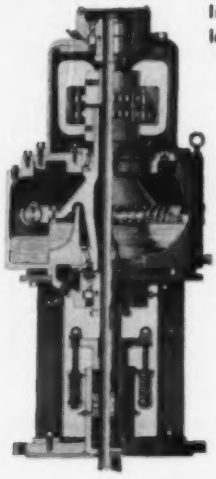

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Patents

genated rosin prepared by a special method.

U.S.P. 2,485,682. Process of Polymerizing a Conjugated Diene in the Presence of a Regulator Comprising Selected Amides of Mercaptyl Undecanoic Acids. K. H. Weber to Armstrong Cork Company.

An open chain aliphatic conjugated diene with 4-6 C atoms, alone or in mixture with a vinyl compound, is emulsion polymerized in the presence of a polymerization regulator comprising an amide of an acid of the formula $CH_2X.CHY.(CH_2)_nCOOH$ in which X and Y are H or SH, but different from one another.

U.S.P. 2,485,906. Catalytic Hydrocarbon Conversion. K. L. Mills, Jr. to Phillips Petroleum Company.

Hydrocarbons are contacted first with an easily reactivable catalyst of low activity and then with a difficultly reactivable catalyst of high activity. Both these catalysts are then reactivated by passing an oxidizing gas over them in series and countercurrent to the flow of the hydrocarbons.

U.S.P. 2,486,183. Emulsion Polymerization of Butadiene in the Presence of a Salt of a Dehydrogenated Middle Fraction of Rosin. J. H. Long and D. H. Sheffield to Hercules Powder Company.

A conjugated butadiene, either alone or in admixture with another organic compound containing the $CH_2=C<$ group, is emulsion polymerized in the presence of an emulsifier consisting of 1-5 percent of an alkali metal salt of a dehydrogenated middle fraction of rosin prepared in a special manner.

U.S.P. 2,486,229. Method and Apparatus for Conducting Gaseous Reactions in the Presence of Solid Particles. E. Utterback to Socony-Vacuum Oil Company, Inc.

Fluid hydrocarbons are converted in the presence of a particle-form contact material maintained as a compact downwardly moving column within a conversion zone. Gaseous hydrocarbon products are collected into a plurality of collecting spaces within the column at locations at which the contact material flow is substantially static. These spaces are shielded from gravity flow of the contact material and distributed uniformly across the cross-section of the column. The gaseous products and any entrained contact material are passed downwardly from each of the spaces into a single settling space within the column where entrained contact material is permitted to settle onto the surface of the contact material column at the lower end of the settling space.

U.S.P. 2,486,361. Catalytic Conversion of Hydrocarbons. P. G. Nahin and H. C. Huffman to Union Oil Company of California.

The conversion of hydrocarbons is effected in the presence of a catalyst comprising a carrier impregnated with an oxide of a Group VIII metal combined with an oxide of a metal of the left-hand column of Group VI of the periodic table. This catalyst is prepared in a manner claimed in detail.

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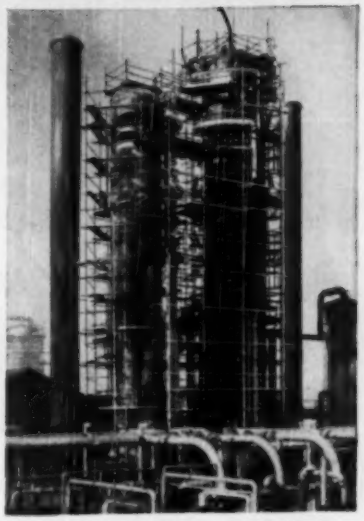

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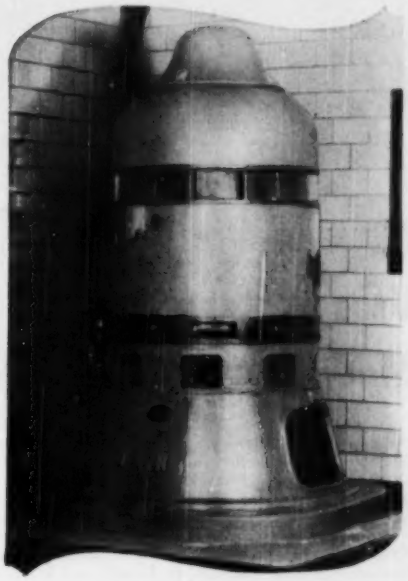

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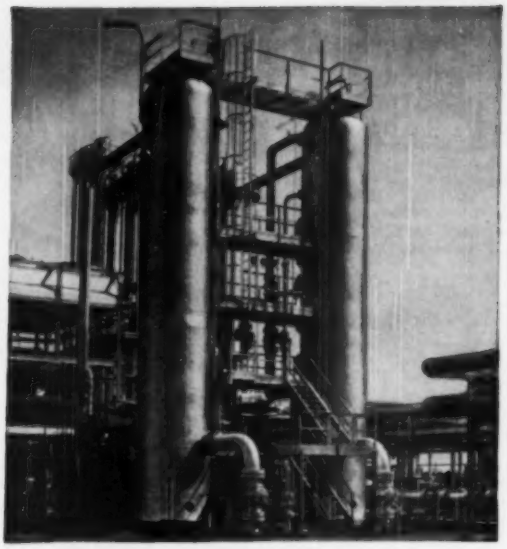

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Patents

U.S.P. 2,486,376. Copolymer of Butadiene and Bornyl Methacrylate. A. B. Craig and D. T. Mowry to Monsanto Chemical Company.

A rubber-like copolymer consists of 40-90 percent of butadiene and 60-10 percent of bornyl methacrylate.

U.S.P. 2,486,533. Process for Producing Selective Polymers. H. C. Mayland and C. G. Gerhold to Universal Oil Products Company.

Details are claimed of a process for polymerizing olefins with 3-5 C atoms in two steps.

U.S.P. 2,486,627. Conversion of Hydrocarbons. P. M. Arnold to Phillips Petroleum Company.

In the conversion of hydrocarbons use is made of a contiguous mass of pebbles gravitating through a series of superposed zones connected by narrow pebble passageways. These zones include pebble heating and cooling zones and a conversion zone in between. The pebbles are heated in the first zone by hot combustion gases to a temperature above that of the conversion of the hydrocarbons introduced into the second zone. Thereafter the pebbles are cooled in the third zone by a stream of oxygen-containing gas and a portion of the conversion effluent. The resulting combustible mixture is burnt in the first zone to heat the pebbles.

U.S.P. 2,486,650. System for Adding Solids to Liquids under Pressure. H. J. Hepp and H. R. Sailors to Phillips Petroleum Company.

Details are claimed of a system for feeding solids into a liquid under pressure, e.g. for adding $AlCl_3$ to pressure reaction systems such as liquid phase alkylation and isomerization of hydrocarbons.

U.S.P. 2,487,743. Method and Apparatus for Catalytic Conversion of Hydrocarbons. H. D. Trotter to Phillips Petroleum Company.

In the catalytic conversion of hydrocarbons by means of a fixed catalyst bed, the lowermost portion of the catalyst bed near the conversion zone outlet is cooled to a temperature low enough to cause condensation and adsorption of undesired high boiling carbonaceous material on this portion of the bed. The condensed high boiling material adsorbed on this bed portion is removed during catalyst reactivation.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

U.S.P. 2,485,073. Hydrocarbon Conversion. W. H. Shiffler and W. H. Claussen to California Research Corporation.

Hydrocarbons are contacted under specified conditions in vapor phase with a solid vanadium oxide and sulfide catalyst at a temperature of 900-1200° F. in the presence of added hydrogen and volatile sulfur. Dehydrogenation of paraffins, olefins, and naphthenes, and cyclization or aromatization of paraffins and olefins can be effected by this method.

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Bodies are one-piece cast steel with stellited seats, meehanite discs, stainless steel stems and bushings. Outside packing gland is stainless steel; gland nut is cold rolled steel.

Okadee Valves with screwed connections are available in sizes ½" through 4" with single and double discs; 2" through 4" sizes, with standard ASA face to face flange dimensions.

Specify Okadee Valves for service in light fluid and gas lines. Their higher quality materials assure lower maintenance cost and perfect service for years.

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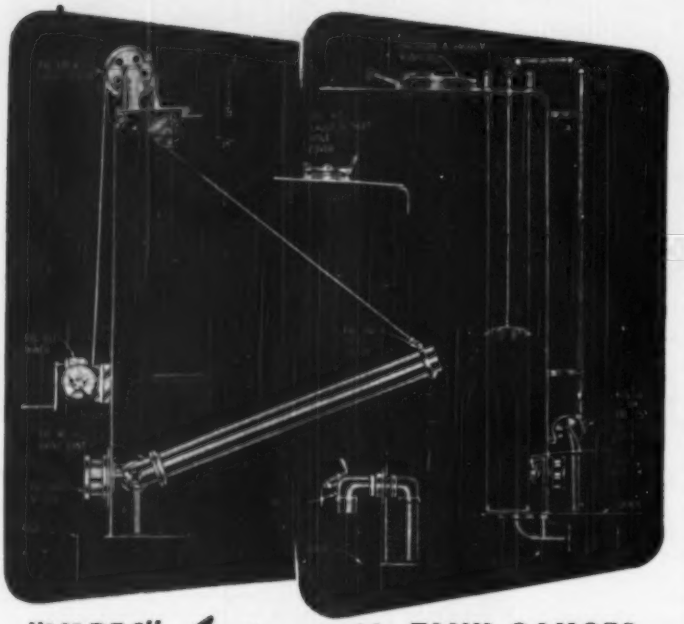

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VAREC gauge hatches, water drawoff valves, drain ells, internal check valves, etc., will safely and reliably complete your tank installation. *Check your needs today.*

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Patents

U.S.P. 2,485,875. Production of Synthesis Gas. M. H. Gorin and A. J. Abrams to Socony-Vacuum Oil Company, Inc.

Details are claimed of a process for the manufacture of synthesis gas in a ratio of $H_2:CO = 2:1$ from natural gas, steam, and CO_2. The charge mixture is first countercurrently contacted with hot liquefied tin or lead and the reaction effluent is then subjected to further treatment.

U.S.P. 2,485,927. Catalytic Dehydrogenation of Hydrocarbons. W. A. Schulze and J. C. Hillyer to Phillips Petroleum Company.

Hydrocarbons are dehydrogenated to form less saturated hydrocarbons by contacting them under suitable conditions with a catalyst consisting of alumina formed by the dehydration of hydrated alumina, together with 2-4 percent of magnesia, 4-6 percent of barium oxides calculated as $Ba(OH)_2$, and 4-6 percent of K_2O calculated as KOH.

U.S.P. 2,485,945. Hydrocarbon Synthesis Process and Catalyst Therefor. S. W. Walker to Sanolind Oil & Gas Company.

A H_2-CO mixture of the vol. ratio $H_2:CO = 2:5$ is contacted with a finely divided fluidized iron catalyst at a temperature of 550-700° F. and a pressure of 100-600 psi. The catalyst is a finely divided metallic iron in plate-like form resulting from the reduction of iron oxide scale obtained as a film on the surface of metallic iron exposed to air at a temperature above red heat.

U.S.P. 2,486,243. Simultaneous Dehydrogenation and Hydrocarbon Synthesis with Fluidized Catalysts in a Single Reactor. H. V. Atwell to The Texas Company.

A CO/H_2 mixture is contacted under synthesis conditions with a synthesis catalyst. A vaporized naphthenic hydrocarbon is simultaneously passed to the reaction zone in contact with a separate dehydrogenation catalyst. Reaction conditions are maintained which permit both reactions to occur simultaneously. The two catalysts are maintained in fluidized condition within the reaction zone in such a manner that one of the catalysts is selectively entrained in the resulting gaseous reaction products. The exothermic heat developed in the CO/H_2 synthesis is thus utilized for the endothermic dehydrogenation. The naphthenes present are converted by the reaction into aromatics with liberation of hydrogen which is consumed at least in part in the synthesis reaction.

U.S.P. 2,486,505. Process for Synthesis of Hydrocarbons and the Like. W. M. Stratford to Texaco Development Corporation.

In a Fischer-Tropsch synthesis process wherein the catalyst temperature is raised by the exothermic heat of reaction while being passed in continuously recurring sequence through the reaction zone and is again diminished in a cooling zone, the catalyst is deposited in a thin permeable continuous layer on the exterior surface of a thin permeable cylindrical support. This support is rotated about a horizontal axis so that the catalyst moves through the two zones during the rotation. The reactant gases

are passed under conversion conditions through the catalyst layer in a radial direction toward the axis of rotation as the catalyst passes through the reaction zone, and a cooled gaseous fraction of the reaction effluent is passed in corresponding direction through the resulting heated catalyst. A hydrocarbon cooling liquid is thereafter correspondingly passed through the catalyst layer while it moves through the cooling zone.

U.S.P. 2,486,633. Synthesis of Hydrocarbons. A. Clark to Phillips Petroleum Company.

In a Fischer-Tropsch synthesis the molar ratio of H_2:CO is maintained between 2:1 and 3:2, the pressure between 15 and 500 psi., the temperature at 150-400° C., and the space velocity of the gases at 100-400. A liquid monohydric alcohol with 1-5 C atoms is introduced and vaporized in the reaction zone in an amount of 0.002-0.0035 pounds per btu. of heat removed from the reaction zone by the alcohol. The temperature in this zone is thus controlled under partial conversion of alcohol to hydrocarbons.

U.S.P. 2,486,879. Manufacture of Hydrocarbons and the Like. H. V. Rees and C. G. Ludeman to Texaco Development Company.

Details are claimed of a process for the manufacture of products with at least 2 C atoms from a mixture of CO and H_2 obtained by the conversion of normally gaseous hydrocarbons. One portion of the gaseous hydrocarbon feed is subjected to complete combustion with exothermic formation of CO_2 and H_2O. The resulting hot combustion gas is contacted with another portion of the feed in an endothermic reaction zone to form a mixture of CO and H_2. This synthesis gas is then passed under specific conditions into contact with an iron catalyst and the products including CO_2 are subjected to further treatment.

U.S.P. 2,486,894. Process for Catalytic Conversion of Carbon Oxides. C. W. Watson to The Texas Company.

In a Fischer-Tropsch synthesis wherein the powdered iron catalyst is maintained in a dense fluidized state in indirect heat exchange with a fluid heat carrier, initial contact of the synthesis gas and the catalyst is effected at a temperature of 550° F. and final contact at 600° F. CO_2 is added to the reactant stream in certain amounts such that net production of CO_2 from the reaction zone is substantially inhibited and the production of methane is at least materially reduced.

U.S.P. 2,486,895. Process for Catalytic Conversion of Carbon Oxides. C. W. Watson to The Texas Company.

A gaseous mixture of CO, H_2, H_2O, and CO_2 is contacted with a fluidized mixture of a particle-form iron catalyst and a particle-form water-gas shift catalyst at a temperature of 550-700° F. until .95-.995 of the CO has been converted into desired products. The composition of the gaseous feed is maintained in a specific ratio to repress and inhibit undesired reactions.

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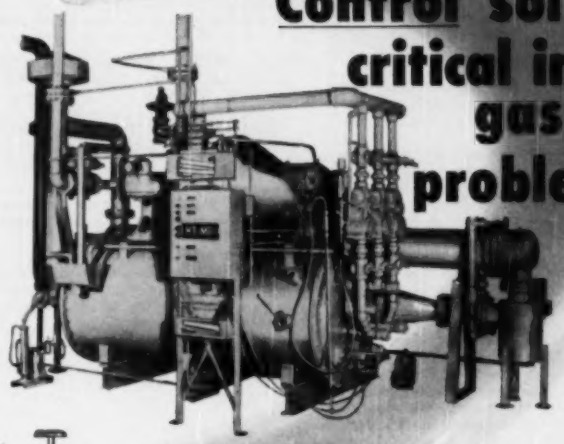

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Company .....
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Patents

U.S.P. 2,486,980. Catalytic Vapor Phase Hydration of Ethylene. S. P. Robinson to Phillips Petroleum Company.

Details of a process are claimed for producing ethyl alcohol from ethylene in two stages of catalytic hydration. High pressure is maintained in the first stage and low pressure in the second stage. Formation of ethyl ether is greatly reduced or eliminated.

DESULFURIZATION

U.S.P. 2,486,519. Desulfurization of Hydrocarbons with Fluosulfonic Acid. J. A. Chenicek to Universal Oil Products Company.

Sulfur-containing hydrocarbon material is contacted with fluosulfonic acid to remove the sulfur.

U.S.P. 2,486,778. Process for the Separation of Acid Gases from Gaseous Mixtures. T. F. Doumani to Union Oil Company of California.

Details are claimed of a process for separating an acid gas from a gaseous mixture, e.g. H_2S from natural petroleum and refinery gases. An aqueous mixture of nitrogen bases is employed for absorbing the acid gases.

U.S.P. 2,487,466. Catalytic Desulfurization of Hydrocarbons. P. G. Nahin to Union Oil Company of California.

Hydrocarbons are desulfurized by heating them to temperatures of 500-1000° F. in the presence of a catalyst consisting of a major proportion of a base prepared by distending more than 5 percent of alumina on bauxite, and a minor proportion of the combined oxides of Co and Mo distended on said base.

U.S.P. 2,487,576. Process for the Removal of Acidic Material from a Gaseous Mixture. C. O. Meyers to Phillips Petroleum Company.

Details are claimed of a process for the removal of acidic material, particularly H_2S from a gaseous hydrocarbon mixture or other gases.

U.S.P. 2,487,577. Absorption Process. C. P. Stanley to Phillips Petroleum Company.

H_2S is removed from a gaseous hydrocarbon mixture by means of an aqueous absorption liquid comprising diethanolamine and diethylene glycol. Details of the process are claimed.

U.S.P. 2,487,578. Prevention of Corrosion of Metallic Surfaces. C. O. Meyers to Phillips Petroleum Company.

In the removal of acidic material including H_2S in an amount of 65-290,000 parts per million from a hydrocarbon fluid mixture by means of an aqueous solution of an organic amine which becomes oxidized and thereby corrosive to the absorption system, 10-250 parts per million of a chrom glucosate are added to the amine solution to prevent corrosion of contacted metallic surfaces.

HEAVY OILS AND WAXES

U.S.P. 2,484,843. Lubricant Composition. J. M. Musselman to The Standard Oil Company of Ohio.

A mineral lubricating oil or grease is described containing at least 0.01 percent of a reaction product of hydrogenated sperm oil with P_2S_5.

U.S.P. 2,485,150. Mineral Oil Composition. F. Y. Glavis and H. T. Neher to Rohm & Haas Company.

A mineral oil with a viscosity of 100-1500 sec. Saybolt at 100° F. is compounded with small amounts of an oil-soluble petroleum sulfonate and an alkylphenoxyethoxyethanol having an alkyl group of 4-12 C atoms. The composition has improved anti-corrosive properties.

U.S.P. 2,485,341. Rust Inhibiting Composition. J. I. Wasson and J. W. Hand, Jr. to Standard Oil Development Company.

A mineral lubricating oil contains 0.05-5 percent by weight of sorbitam- or penetaerythritol-mono-oleate and 0.05-3 percent of tributyl- or tri-p-tert.-butylphenylphosphite. The additives prevent rusting and corrosion of metal parts exposed to moisture.

U.S.P. 2,485,861. Lubricating Oil. S. E. Campbell and I. S. Dellinger.

A lubricating hydrocarbon oil contains a permanent dispersion of a hydroxide or carbonate of an alkaline earth metal and an oil-soluble mahogany sulfonate as the dispersing agent. The formation and adherence of lacquers and carbonaceous deposits on pistons and rings is minimized by the additive.

U.S.P. 2,486,014. Hydrocarbon Oil Dewaxing. G. H. Evans to The Atlantic Refining Company.

A waxy hydrocarbon oil which contains high melting and low melting waxes is separated into oil and wax fractions by means of a selective solvent for the oil in a process claimed in detail.

U.S.P. 2,486,188. Lubricant. R. L. May to Sinclair Refining Company.

A lubricating petroleum oil contains a small amount of a P- and S-containing reaction product obtained by treating turpentine with P_2S_5 or P_2S_3 at temperatures above 200° F. The additive represses oxidation of the oil.

U.S.P. 2,486,493. Oil Compositions. A. J. Revukas to Tide Water Associated Oil Company.

Mineral oil is compounded with a small amount of a polymerized ester of the acrylic acid series and a small amount of an oil-soluble aliphatic ester of a phosphorus acid. While the first named additive improves the lubricating characteristics of the oil but imparts to it an increased emulsifying tendency, the second additive reduces this tendency again.

U.S.P. 2,487,151. Lubricant Composition. E. Lieber and A. F. Cashman to Standard Oil Development Company.

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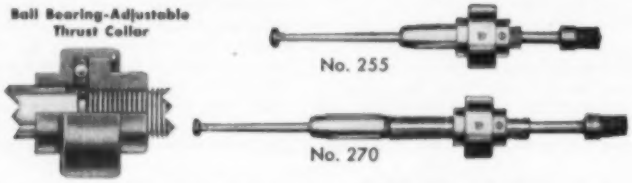

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Expanders may be adapted for use with Automatic Torque Controlled Operating Units, for precision tube rolling.

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A waxy mineral lubricating oil is compounded with 0.05-2 percent of a co-condensation product of 20-300 parts of chlorinated paraffin wax containing 10-20 percent chlorine with 100 parts of stearyl chloride. The condensation product with an average molecule weight of 1000 has wax-modifying properties and works as pour depressor.

U.S.P. 2,487,260. Extreme Pressure Lubricants. A. J. Morway to Standard Oil Development Company.

An extreme pressure lubricant comprises at least 60 percent mineral lubricating oil, 5-25 percent carbon black containing 3-20 parts of acetylene black and 0.5-10 parts of high modulus black, a metal soap, a tackiness agent (e.g. an oil solution of a polymer), and a non-corrosive extreme pressure agent (e.g. a sulfurized fatty oil).

U.S.P. 2,487,261. Low-Temperature Grease. J. C. Zimmer and A. J. Morway to Standard Oil Development Company.

A grease consists of 70-90 percent by weight of a mineral lubricating oil, 2-20 percent of a channel carbon black coated with a material of the approximate formula $R_xSi(OH)_y$, wherein R is an alkyl radical with not more than 3 C atoms and x and y are integers 1-3, 2-15 percent of acetylene black, and 0.1-3 percent of zinc naphthenate. The grease has improved stability and resistance to oxidation.

U.S.P. 2,487,306. Treatment of Lubricating Oils. P. H. Carnell to Phillips Petroleum Company.

Lubricating oil is contacted with anhydrous liquid HF to form a separate acid phase, and with cyclopentane, methylcyclopentane, cyclohexane, or methylcyclohexane in an amount of 1.3-1.7 times the weight of the oil at elevated temperature and at a pressure sufficient to maintain the HF and hydrocarbons in liquid phase. Substantial increase in the viscosity index and stability of the lubricant is effected.

U.S.P. 2,487,376-9. Lubricant. T. G. Roehmer and G. W. Murray to Socony-Vacuum Oil Company, Inc.

A mineral oil base lubricating grease contains 8.5-48 percent of a fatty material, 1.5-7.5 percent of an alkali or alkaline earth metal hydroxide, and 0.5-15 percent of a water-dispersible polyvinyl alcohol. The grease is resistant to deformation and "bleeding." Instead of the polyvinyl alcohol a water-dispersible protein is employed according to U.S.P. 2,487,377, or a water-dispersible phenol-formaldehyde resin (U.S.P. 2,487,378), or a natural gum (U.S.P. 2,487,379).

PETROCHEMICALS

U.S.P. 2,485,017. Production of Aryl Dihaloalkanes. L. Schmerling to Universal Oil Products Company.

An aromatic hydrocarbon with a replaceable nuclear hydrogen atom is reacted with a dichloroolefin in which the double bond is located at a tertiary C atom in the presence of a catalyst complex of a Friedel-Crafts halide and an alkanol, alkyl ether, alkyl ketone, or nitroparaffin.

U.S.P. 2,485,044. Vinyl Acetate Production. W. H. Gehrke to Monsanto Chemical Company.

A gaseous mixture of acetylene and acetic acid is contacted at a temperature of 150-300° C. with a catalyst consisting of particles of a carrier made by devolatilizing bituminous coal with 3-8 percent ash, and then activating this coal by steam until the ash content of the carrier is in the range of 15-35 percent ash. Zinc acetate is present on the surface of the carrier particles.

U.S.P. 2,485,125. Esterification of Aryl Vinyl Compounds. J. M. Wilkinson, Jr. to General Aniline & Film Corporation.

Styrene is heated in liquid phase at atmospheric pressure to a temperature of at least 50° C. in admixture with an excess of a lower monocarboxylic aliphatic acid and in the presence of nitric acid and a polymerization inhibitor for styrene. Alpha-methyl benzyl esters of the aliphatic acids are obtained.

U.S.P. 2,485,180. Liquid Sulfur Dioxide Solvent Process for Making Olefin Nitrosochlorides. R. K. Allison to Food Machinery & Chemical Corporation.

A cyclic olefin is dissolved in liquid SO_2. At a temperature below —10° C. nitrosyl chloride is passed through the solution. The resulting hydrocarbon nitrosochloride is separated.

U.S.P. 2,485,185. Nitroparaffin Solvent Process for Making Olefin Nitrosochlorides. C. Bordenca and W. A. Lasier to Food Machinery & Chemical Corporation.

An olefin with at least 6 C atoms is dissolved in a nitroparaffin with 1-8 C atoms. The solution is treated in the manner indicated in U.S.P. 2,485,180 for the same purpose.

U.S.P. 2,485,237. Synthesis of Aromatic Aldehydes. W. F. Gresham and G. E. Tabet to E. I. du Pont de Nemours & Company.

A mixture of aromatic hydrocarbon and CO is subjected to the action of a mixed anhydrous HF-BF_3 catalyst at a temperature of —80° to +50° C. under increased pressure. Aromatic aldehydes are obtained.

U.S.P. 2,485,315. Controlled Severity Fluid Coking. W. A. Rex and B. E. Roetheli to Standard Oil Development Company.

Heavy hydrocarbon oils are coked by a process claimed in detail. Lack of control of severity of heat treatment of the coking vapors is overcome by maintaining a dense bed of fluidized coke particles in the coking zone at temperatures suitable for the production of volatile conversion products and coke, and maintaining a dilute phase suspension of the coke particles immediately above the dense bed.

U.S.P. 2,485,342. Method for Oxidation of Aromatic Hydrocarbons. A. B.

Patents

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THE C. O. JELLIFF MANUFACTURING CORPORATION SOUTHPORT, CONN.

Patents

Welty, Jr. to Standard Oil Development Company.

A vaporizable aromatic hydrocarbon, e.g. naphthalene, is partially oxidized under controlled temperature conditions by passing 0.5-2 mole percent of this hydrocarbon in an oxidation gas through a wire screen coated with vanadium oxide at a velocity of 1-10 feet per second. Phthalic anhydride is a preferred reaction product.

U.S.P. 2,485,911. Petroleum Extract-Sulfur Dioxide Reaction Product. E. S. Narracott to Anglo-Iranian Oil Company, Ltd.

A predominantly aromatic hydrocarbon extract obtained in the solvent extraction of a wax-free petroleum base lubricating oil is reacted with SO_2 at a temperature of 150-300° C. to form a resin useful in the production of coating compositions.

U.S.P. 2,486,441. Condensation of Olefins with Organic Compounds. F. M. Seger and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

A mono-olefinic hydrocarbon with at least 3 C atoms is condensed with an olefinic mono-oxide, or mono-sulfide, or mixtures thereof in an amount of at least 0.1 mol per mol of the hydrocarbon at temperatures of 500-700° F. The resulting products are particularly useful as lubricating oils.

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PETROLEUM SERVICE DIVISION

U.S.P. 2,486,454. Polybasic Acids and Method for Producing the Same. C. N. Zellner to Tide Water Associated Oil Company.

Paraffins are contacted in liquid phase at a temperature of 120-180° C. with a gas containing free oxygen. The rate of feed of the gas to the hydrocarbons and the gas distribution therein is controlled in a particular manner to effect partial oxidation of the paraffins. Dibasic organic acids are the most important reaction products obtained.

U.S.P. 2,486,693. Method for the Synthesis of Carbinols. P. van't Spijker and J. A. Sherred to Shell Development Company.

In the production of alcohols by treatment of unsaturated hydrocarbons with CO and H_2, the hydrocarbon is continuously passed in the liquid phase and in the presence of a catalyst serially through separate but intercommunicating reaction zones maintained at different temperature levels and being in heat exchange relationship. An excess of a CO/H_2-mixture is passed through the first zone, and an excess of H_2 through the second zone. The excess gases from these zones are combined and recycled to the first zone.

U.S.P. 2,486,842. Catalytic Oxidation of Hydrocarbons. G. W. Hearne and M. L. Adams to Shell Development Company.

A gaseous mixture of oxygen, an olefin with at least 3 C atoms, and 0.002-0.2 mole percent (based on the olefins) of an aliphatic chloride is contacted with a solid Cu_2O catalyst maintained at 200-600° C. under suitable correlated conditions of temperature, contact time, and mixture. Unsaturated aldehydes and ketones with the same number of C atoms as the olefin are produced, e.g. acrolein from propylene, methacrolein from isobutylene.

U.S.P. 2,486,934. Process for the Production of Nitriles. M. Erchak, Jr. to Allied Chemical & Dye Corporation.

A gaseous mixture of oxygen, ammonia, and an alkyl substituted cyclopentane with at least 2 C atoms in the alkyl substituent, or an alkyl substituted cyclohexane is contacted at a temperature of 350-600° C. with a catalyst for the vapor phase partial oxidation of benzene and naphthalene, e.g. a catalyst containing the oxides of V, Mo, and P. The gaseous mixture shall contain at least one mol ammonia for every mol of the organic compound. Aromatic nitriles are obtained.

U.S.P. 2,487,338. Condensation of Aromatic Hydrocarbons with Terpenes. G. C. Johnson and J. Kellett, III to Socony-Vacuum Oil Company, Inc.

A terpene is added to an aromatic hydrocarbon at a rate of less than 3 g. per minute per mol of ar. hydrocarbon until the mixture contains 50 mol percent of terpene. The addition is made in the presence of an aluminum halide alkylation catalyst at a temperature of 40-140° C. Condensation of the components is effected, e.g. that of toluene with dipentene.

NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages write to the address shown, using the number shown for each item desired.

Steed Hardening (Item 1)

A method of hardening stainless steel, developed by C. U. Scott and Son, Inc., is said to offer advantages in many applications. The method, which hardens stainless steel machine parts requiring precision tolerances up to two ten thousandths, gives these parts a case of two to three thousandths with a Rockwell reading of 68-70 C. Steel "so processed becomes hard enough to scratch a diamond and cut glass." While the case depth is light, it is claimed to have exceptional wearing qualities. The hardening prevents galling and the metal retains most of its stainless qualities. This process opens new fields for types 302, 303, 304, 316, 410, 416, 420 and 440 stainless steel.

For further information write C. U. Scott and Son, Inc., Rock Island, Ill., referring by number to this PETROLEUM REFINER item.

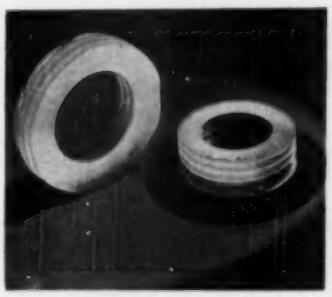
SO_2 Analyzer (Item 2)

The Thomas autometer, manufactured by Leeds & Northrup Company, continuously records concentration of sulfur dioxide in parts per million, warning against atmospheric pollution. The instrument also records average concentration integrated over a half hour period, automatically checks its "zero reading" every 30 minutes and marks off each cubic foot of air sampled. Electrolytic conductivity is the means of measurement. A continuous sample of air is passed through a solution which absorbs sulfur dioxide, causing a change in the electrolytic conductivity of the solution.

For further information write Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, referring by number to this PETROLEUM REFINER item.

Expansion Joint (Item 3)

A new type of expansion joint that is "positively" non-corroding and non-contaminating" has been announced by United States Gasket Company. This joint is made of Teflon, a du Pont material that is claimed to be impervious to industrial chemicals and withstand



temperatures up to 500° F. and down to —150° F. Connectors for installing these joints can be so applied that no surface except the inert Teflon comes into contact with material carried by the piping.

For further information write United States Gasket Company, 602 North 10th Street, Camden, N. J., referring by number to this PETROLEUM REFINER item.

High Speed Steels (Item 4)

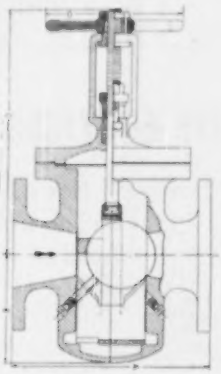
The working of tool and high-speed steels is described in a "blue sheet" of Allegheny Ludlum Steel Corporation. Included are a simple selector chart, procedures and tabulations for makers and users of cutting tools and dies. Also discussed are design, machining, cutting-tool angles, speeds, heat treatment, and grinding. The booklet is for use in conjunction with the other blue sheets in the series which give in detail the properties of each type of tool and high-speed steel.

For further information write Allegheny Ludlum Steel Corporation, Room 2036, Henry W. Oliver Building, Pittsburgh 22, referring by number to this PETROLEUM REFINER item.

Ball Valves (Item 5)

Straight through, non-turbulent flow is one of the features claimed for Paul Valve Corporation's venturi-ball valves. Bulletin 103 gives the principle of operation and engineering data on this line, including "whistle" valves, bar stock valves, cast steel and stainless steel valves, and forged valves. Pictured here is the 1000 series for 150 psi. service, a cast stainless valve available in sizes 1, 1¼, 1½, 2, 2½, 3 and 4 inches. Other features claimed for these valves include throttling with smooth flow, straight line characteristics; tight shut-off; free, easy opening and closing without binding or galling. The valves are sold to the petroleum industry by W. K. M. Company, Inc., Houston, and to all other industries by Paul Valve Corporation.

For a copy of the bulletin write Paul Valve Corporation, 683 Third Avenue, New York 17, referring by number to this PETROLEUM REFINER item.

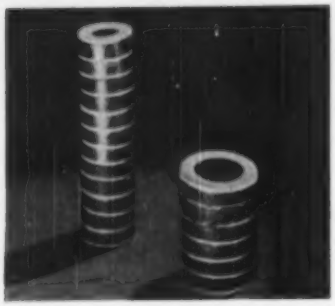


Shaft Packing (Item 6)

Made of graphite or mica combined with Teflon, chemiseal No. 711, a new shaft and pump packing, developed by United States Gasket Company, is adapted to applications where chemical attack from solvents, acids or alkalies, or contamination of the product is a serious problem. Under even slight gland pressure, the graphite-filled rings are forced into a leak-proof seal against the shaft periphery. The natural lubricating properties of both the graphite and Teflon make any additional lubricant unnecessary in many applications. Solid Teflon rings are used at each end of the packing and alternately throughout the packing to preclude the possibility of flow through the packing itself.

For further information write United

New Equipment



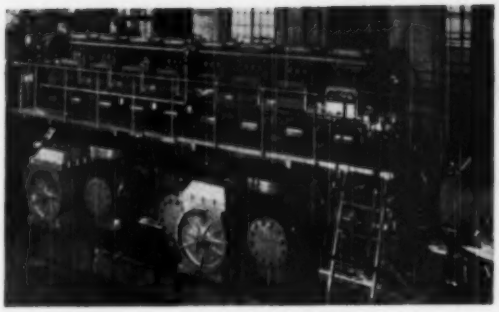
States Gasket Company, 602 North 10th Street, Camden, N. J., referring by number to this PETROLEUM REFINER item.

Wrenches (Item 7)

Forty-five degree and 90 degree bent handle construction wrenches in carbon and alloy steels are offered by J. H. Williams & Company, to "facilitate work in close quarters where maximum accessibility and leverage are required." This type of wrench is "particularly useful on flange and pipe line work in refineries, chemical plants and industries using processing equipment." Openings are ⅞ inch to 2 inches.

For further information write J. H. Williams & Company, 400 Vulcan Street, Buffalo 7, N. Y., referring to this PETROLEUM REFINER item.

Engine Compressor (Item 8)



The newly developed Uniflo scavenging-principle gas engine compressors of Worthington Pump and Machinery Corporation and claimed to be revolutionary in gas engine design. Air inlet ports around the entire circumference at the bottom of the cylinder and dual, mechanically operated exhaust valves at the head produce perfect clearance of burnt gases from the cylinder. Also featured are complete charging with clean air, etremely low exhaust temperatures and assured load carrying ability.

For further information write Worthington Pump and Machinery Corporation, Harrison, N. J., referring by number to this PETROLEUM REFINER item.

Scale Remover (Item 9)

"Doctor Boiler," a scientific preparation of Doctor Boiler, Inc., for the prevention and removal of boiler scale, provides a microscopic film which covers the inside of the boiler and seals off the moisture and chemical action of the water from the scale itself. The preparation is designed to work in all types of water which eliminates the necessity of water sampling in connection with its use. Additional properties claimed are the prevention of corrosion and foaming.

For further information write Doctor Boiler, Inc., 4316 Main Street, Dallas, referring by number to this PETROLEUM REFINER item.

Safety Cage (Item 10)

Up Right Scaffolds, a division of Up-Right, Inc., has manufactured a roll-around and safety cage for types of tank-work — painting, scraping, sand blasting, and inspecting. The cage weighs 70 pounds and the roll-around weighs 48 pounds. It has a vertical clearance over obstacles of 44 inches. Its load capacity is 1000 pounds with a safety factor of four. The improved roll-around for use with the safety cage is shown in the accompanying photo. It is fastened by a cable to the center of the tank, and the cage is suspended by a block-and-tackle from any one of several attaching positions on the roll-around which give

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Kellogg has engineered Atmospheric Distillation units for more than 35 different oil companies including:

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Argentine Government Oil Fields
Atlantic Refining Co.
The British American Oil Co. Ltd.
Cie. Francaise de Raffinage
Cities Service Refining Corporation
Consolidated Refineries, Ltd.
Continental Oil Co.
Esso Standard Oil Co.
Imperial Oil Limited
Magnolia Petroleum Co.
National Petroleum Council of Brazil
Pan American Refining Corporation
Societe Generale des Huiles de Petrole
Societe Industrielle Belge des Petroles
Socony-Vacuum Oil Co.
Standard Oil Company (Indiana)
The Standard Oil Company (Ohio)
Standard Oil Co. of California
The Texas Company
Union Oil Company of California

One million barrels of crude pass through Kellogg-built distillation units every 24 hours . . .

...Yes! Now more than 1,000,000 barrels of crude are processed each day in Kellogg distillation units... with additional capacity underway on three different continents!

KELLOGG built its first atmospheric distillation unit more than a quarter century ago—when many of the primary distillation facilities of other types were already in existence. Yet since that date Kellogg units have been installed on five continents in more than fifty different locations.

The applications have ranged from virtual skimming in Palestine where more than half of the crude was returned to ground reservoirs to the accurate fractionation of Pennsylvania crude.

They've been designed as independent units and in combination with decarbonizing, coking, cracking, vacuum distillation, visbreaking and reforming. Individual capacities have ranged from 1,000 to over 40,000 BPD.

In a phase of oil processing such as this, where building contracts are customarily open to practically any bidder, there must be definite reasons for *the record concentration in one company's hands* of contracts for more than a million barrels of capacity.

Kellogg invites refiners, who are modernizing old facilities or increasing crude capacity, to examine with its engineers the reasons for this preference.

FURNACE DESIGN AND TOWER "FLUIDYNAMICS" DETERMINE EFFICIENCY

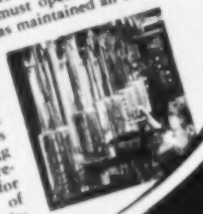
Atmospheric Distillation is in essence a simple process—comprising only two unit operations—yet there are many pitfalls that can markedly affect stream efficiency. One would think that, with a process more than twenty-five years old, all important factors would have been discovered and formulated. But such is not the case with either furnaces or bubble towers. There is still much to be learned and new data are being obtained every day. That is why, over this entire period, Kellogg has never ceased to gather and evaluate operating data from all over the world, and has carried on continual research on both items of equipment.

Along these lines, the Lucite bubble tower (shown here) continues to operate in the Kellogg Engineering Laboratories, permitting engineers to carry on investigation of the problems of "Fluidynamics"—cap spacing, types of trays, dumping, entrainment and a host of other details.

IT TAKES ALL SEVEN TO PRODUCE GREATER EARNING POWER...

1 THE DEVELOPMENT "TOOLS"

both equipment and people—to improve processing and equipment ideas. Most refiners know of Kellogg's extensive pilot plant and chemical laboratories—know the professional reputations of the men who guide their activities. But processes are only as good as the equipment within which they must operate. That is why, over the years, Kellogg has maintained an extensive Metallurgical Research and Development operation. Materials, fabrication methods and new types of equipment are its permanent projects. The contributions of this group to the Kellogg organization have been responsible in a major way for the superior efficiency of Kellogg refinery units.



2 PROCESS ENGINEERING by three distinct groups of specialists—*sequence* engineers, *unit* engineers and *development* engineers—supported by an extensive reservoir of exclusive data.

3 SPECIALISTS IN EVERY PHASE of design engineering due to the completeness of Kellogg's engineering staff.

4 SPECIALIZED BUYERS backed by the cumulative buying power of the largest company in the business.

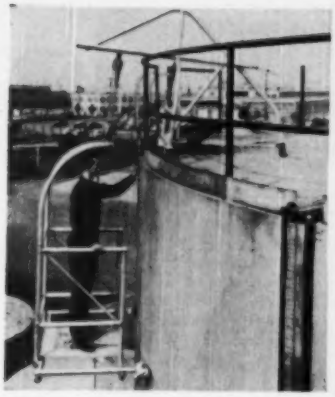
5 COMPLETE FABRICATING FACILITIES to make schedule deadlines and to develop workable "firsts" in refinery equipment.

6 CONSTRUCTION KNOW-HOW acquired in completing hundreds of major jobs, plus an ample supply of the proper tools, and the constant development of new money-and-time-saving methods on the construction lot.

7 PRACTICAL OPERATING COUNSEL on all design and construction, achieved through practical operating men working as an integral part of the company.

...AND ONLY KELLOGG HAS ALL SEVEN!

The M. W. Kellogg Company, (a subsidiary of Pullman, Inc.), New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris



a overhang distance of 18, 24, 30, 36 or 40 inches.

For further information write Up Right Scaffolds, 1013 Pardee Street, Berkeley 2, Calif., referring by number to this PETROLEUM REFINER item.

Water Baths (Item 11)

Constant temperature water baths, in several designs, have been developed by Henry A. Gardner Laboratory, Inc. All models are supplied for operation on 110-volt, 60-cycle ac. unless otherwise specified. These baths are fitted with precision built pre-set thermo regulator set to maintain temperature at 77° F. —0.2°. A wider range of temperature is possible through an additional thermo regulator. Construction is of glass aquarium type or stainless steel.

For further information write Henry A. Gardner Laboratory, Inc., 4723 Elm Street, Bethesda, Md., referring by number to this PETROLEUM REFINER item.

Level Controllers (Item 12)

Levelimeter instruments to indicate, measure and control liquid level and inter-face level are described in illustrated catalog section 75 of Fischer & Porter Company. Variations in liquid level in weirs and flumes are utilized for measurement and control of large flow rates. Described are magnetic tape-and-drum, electronically transmitting, ball-float, pneumatic and differential pressure units; V-notch weir and Parshall flume flowmeter instruments; and chemical service sight gage glasses.

For a copy write Fischer & Porter Company, 75 County Line Road, Hatboro, Pa., referring by number to this PETROLEUM REFINER item.

Linings (Item 13)

A method of applying corrosion resistant linings of polyethylene to metal surfaces has been developed by Schori Process Division, Ferro-Co Corporation, and is available for immediate application. Bulletin No. 103D describes the method in which polyethylene powder is sprayed through a flame spray pistol. Properly applied, the polyethylene coating is said to be fully resistant to attack of almost all chemicals at temperatures of 180° F. The bulletin includes tables showing the results of tests by the Schori Process Division and E. I. du Pont de Nemours, on a list of chemicals.

For a copy write Schori Process Division, Ferro-Co Corporation, 8-11 Forty-Third Road, Long Island 1, N. Y., referring by number to this PETROLEUM REFINER item.

Rust Inhibitor (Item 14)

A new rust inhibitor for light oil products in pipe lines and static storage is available from Monsanto Chemical Company. A hydrocarbon-soluble, water-insoluble, non-metallic organic material, it will be sold under the trade name Santolene C and is intended to be used in such products as gasoline, fuel oil, and kerosine. The new product is sufficiently effective at a dosage of 0.002 percent by weight, or 0.75 gallon per 1000 barrels, when tested according to modified ASTM D-665-47T against distilled water. Concentrations up to 0.01 percent may be needed against sea water.

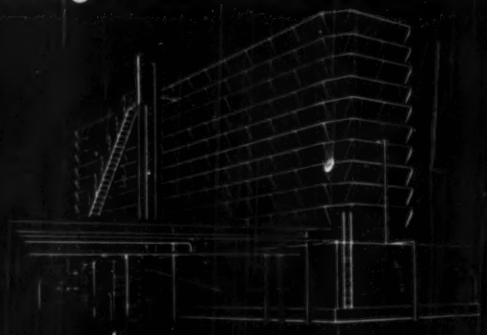
For further information write Monsanto Chemical Company, St. Louis 4, Mo., referring by number to this PETROLEUM REFINER item.

New Equipment

Drum Filler (Item 15)

The Yale & Towne Manufacturing Company has introduced a series of new hydraulically operated devices that can be applied to standard industrial trucks that will permit them to handle mechanically, safely and speedily any kind of material, liquid or bulk, in bags, boxes, or barrels. Included in the series is the precision, air operated drum filler, pictured here, which automatically fills 52 gallon drums within six ounces of the

How to Solve *Your* Cooling Water Problems . . .



No two cooling water problems are ever identical. Variables include the water itself, the cooling equipment and operating requirements as well as atmospheric conditions that change with the seasons and with the hour. Without continuous chemical control the development of scale, or corrosion, or biological fouling will cause inefficient operation of the entire cooling system.

For the solution of even the most unusual cooling water problem BETZ offers a complete consulting engineering service. Over two decades of experience have made Betz water conditioning service scientifically correct, complete, economical. Our nation-wide staff of engineers will welcome the opportunity of discussing your water problems.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.

BETZ

COOLING WATER CONDITIONING · BOILER WATER CONDITIONING

New Equipment

desired weight without the fire and explosion hazards commonly experienced with electrical equipment. The filling device will fill any size container.

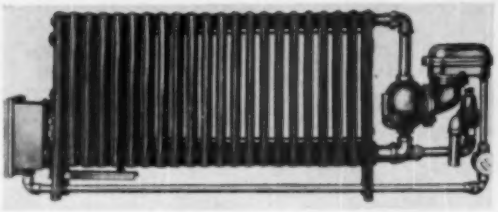
For further information write The Yale & Towne Manufacturing Company, 815 N. LaSalle Street, Chicago, referring by number to this PETROLEUM REFINER item.

Centrifugal Pump (Item 16)

An instruction booklet on the installation and operation of centrifugal pumps in corrosive service has been issued by The Duriron Company, Inc. While dealing specifically with Durcopumps, the information is applicable to all centrifugal pumps. Also discussed is the proper location of pumps, proper foundation for them, correct alignment, priming standard pumps, proper piping arrangements, adjustment of impellers, common troubles and how to overcome them.

For a copy write The Duriron Company, Inc., Dayton 1, Ohio, referring by number to this PETROLEUM REFINER item.

Radiator (Item 17)



An explosion-proof electric radiator, developed by Burnham Corporation, has been approved by Underwriters' Laboratories, Inc., for use with "complete" safety in Class 1-Group D atmospheres: vaporized products, butane, alcohol, acetane, and natural gas; Class 2, Groups F and G atmospheres: carbon black, coke, flour, starch and grain dusts. The unit has thermostatically controlled heat output. Automatic controls prevent internal pressures from building up above 30 psi. All radiators are hydrostatically tested for pressures to 140 psi. Cast iron tubes produce both radiant and convected heat in the radiator which comes filled with a solution of water and anti-freeze. The water may be used repeatedly.

For further information write Burnham Corporation, Electric Radiator Department, Irvington, N. Y., referring by number to this PETROLEUM REFINER item.

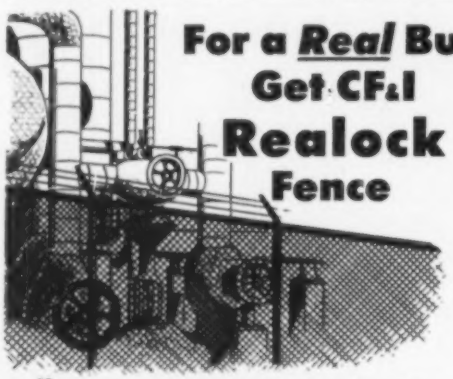
Strainers (Item 18)

Bulletin S-202 is a revised publication on Yarnall-Waring Company's strainers which gives pressure and screen data tables not included in the original issue. Prices, weights and dimensions are also given. Installation and replacement of strainers is explained, and a chart gives types, sizes, pressures and temperatures.

For a copy write Yarnall-Waring Company, Mermaid Lane, Philadelphia 18, referring by number to this PETROLEUM REFINER item.

Stacker (Item 19)

Stacker shown here is offered as a standard unit in the "Portelvator" line of lifting, positioning, and transporting equipment manufactured by The Hamilton Tool Company. Of fabricated construction throughout, and utilizing the patented Portelvator lifting principle, the stacker has a load capacity of 1000 pounds. Maximum height of platform surface from floor is 58 inches with a minimum of 6 inches. The platform



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Here's why so many refineries have found that REALOCK® Fence is a REAL buy:

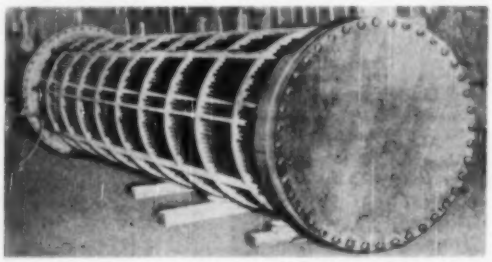
- first cost is moderate
- harmonizes with any style architecture
- made of steel and galvanized after weaving, it is strong and durable; lasts for years without costly maintenance
- fence and gates are tailor-made to provide protection desired
- tamper-proof fittings and hard-to-climb diagonal mesh provide REAL protection

Free Estimates...Expert Installation Service
FHA TERMS AVAILABLE
FOR A *REAL* BUY, BUY *REALOCK*

Realock fence

CF&I

The Colorado Fuel and Iron Corporation
General Offices: Denver, Colorado
Pacific Coast Sales: The California Wire Cloth Corporation, Oakland, Calif.



Superior Built 48" Heat Exchanger With 22,000 Ft. of ¾" Tubing.

AVOID DELAY
THE *SUPERIOR* WAY!

Superior's prompt RETUBING SERVICE cuts downtime cost by saving you every possible minute on rush jobs.

Superior builds NEW HEAT EXCHANGERS to your exact specifications. There's no hold-up in putting new units in service.

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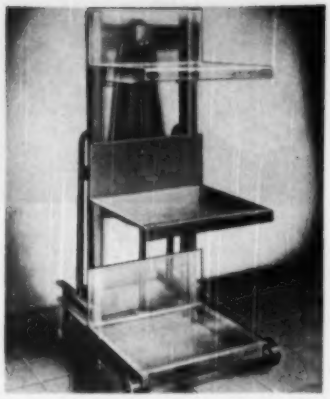
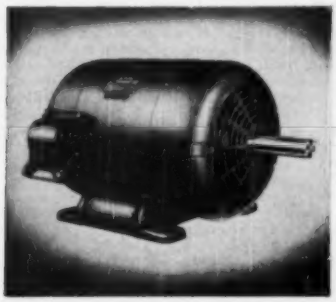


automatically locks at any position stopped, and cannot slip or "settle" under the load. Platform movement is through hand crank, roller chain, meshing bevel gears, and screw.

For further information write The Hamilton Tool Company, Hanover at Ninth, Hamilton, Ohio, referring by number to this PETROLEUM REFINER item.

Motors (Item 20)



Squirrel cage, totally enclosed, type CSP, explosion-proof Life-Line motors are available from Westinghouse Electric Corporation in frames 224 to 326, in 1 to 20-hp. ratings, for 2 and 3-phase, 25, 50, 60-cycle, 208, 220, 440, 550-volt service. These motors are designed for constant speed drive applications, such as pumps, blowers, or compressors, and may be safely used in any location where Class I Group D explosive materials or atmospheres are encountered. Heavy steel construction is used for resistance to corrosive atmospheres.

For further information write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, referring by number to this PETROLEUM REFINER item.

Tank Heating (Item 21)

Tank heating and cooling is described in a Kold-Hold Manufacturing Company bulletin which makes a direct comparison between the Platecoil and pipe coil methods of heat exchange. Platecoil is said to take only half the tank space, yet heats faster than pipe coil.

For a copy write Kold-Hold Manufacturing Company, Lansing, Mich., referring by number to this PETROLEUM REFINER item.

Conveying Systems (Item 22)

The unloading and conveying of dry pulverized materials are described in Bulletin FK-25 of Fuller Company. Typical applications and component equipment, including valves, material-level indicator, aeration unit, sampler and rotary valves are described.

For a copy write Fuller Company, Fuller Building, Catasauqua, Pa., referring by number to this PETROLEUM REFINER item.

Gas-Fume Respirator (Item 23)

Mine Safety Appliances Company's gas-fume respirator is described in Bulletin CR-23. Designed to combine protection with working comfort, the respirator employs twin replaceable filters which are mounted on the wearer's back. Back-mounting removes the filters from areas of heavy contaminant concentrations, and also permits unobstructed vision and complete working freedom.

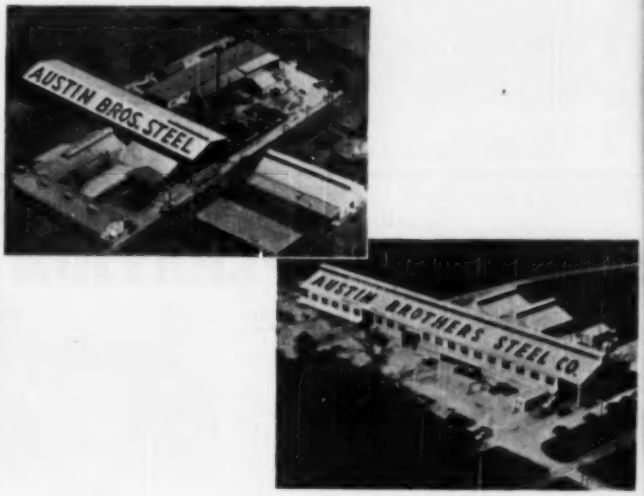
For a copy, write Mine Safety Appliances Company, Braddock, Thomas and Meade Streets, Pittsburgh 8, referring by number to this PETROLEUM REFINER item.

Dial Gage (Item 24)

Helicoid Gage Division of American Chain & Cable Company, Inc., has added to its line an illuminated dial gage which is lighted like the new auto-

SERVING THE INDUSTRY

FROM 2 GREAT PLANTS



- *Structural Steel*
- *Reinforcing Steel*
- *Steel Warehouse Products*

AUSTIN BROS. STEEL CO.

GENERAL OFFICES
1815 COOMBS STREET
DALLAS 1, TEXAS

PLANTS
DALLAS, TEXAS
HOUSTON, TEXAS

New Equipment

mobile speedometers with black light that glows in the dark. This gage, made in a square case for flush mounting on a panel, has dials with a black background and ultraviolet phosphorescent pointer, numerals and graduations, or plain white illumination may be supplied. It is made in standard 4½, 6 and 8½-inch dial sizes with the same drilling dimensions as conventional round case gages. The Helicoid movement, which means there are no teeth to wear out; stainless steel bearings, fused joints, Korex steel Bourdon tubes, and the external pointer adjuster are featured.

For further information write Helicoid Gage Division, American Chain & Cable Company, Inc., Bridgeport 2, Conn., referring by number to this PETROLEUM REFINER item.

Fire Extinguisher (Item 25)

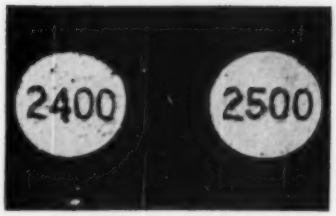
An improved model dry chemical fire extinguisher, model B, said to be completely water-tight, has just been introduced by Ansul Chemical Company, as an improvement over Model A, its predecessor. Chief among the 12 new design features are the nozzle and cartridge receiver, which are said to be water-tight because of specially designed seals. Other features are threaded hose connections, cartridge guard finger grip and redesigned carrying handle. The extinguisher is available in 20 and 30 pound sizes.

For further information write Ansul Chemical Company, Marinette, Wis., referring by number to this PETROLEUM REFINER item.

Pellets (Item 26)

Tempil® Corporation has announced development of additional high temperature ratings of pellets to indicate 2100°, 2200°, 2300°, 2400°, and 2500°F. Beginning with 113°F., pellets are now available in 12½-degree steps to 400°F, in 50-degree steps from 400° to 2000°F, and in 100-degree steps from 2000° to 2500°F.

Photo shows 2400° pellet starting to melt on surface which had been heated to between 2400° and 2500°. Note that the 2500° pellet remains intact.



For further information write Tempil® Corporation, 132 West 22nd Street, New York 11, referring by number to this PETROLEUM REFINER item.

Centrifugal Pump (Item 27)

No bearing bracket is employed in The LaBour Company, Inc.'s Type BGM centrifugal pumps. Described in Bulletin 53, the pump has one moving part, the impeller, which is mounted directly on an extended motor shaft protected against corrosion. Also discussed are the seal, provided without packing or close clearance; applications; self-priming; instructions for installation and care; operating information; and data on friction of water in pipes.

For a copy write The LaBour Company, Inc., Elkhart, Ind., referring by number to this PETROLEUM REFINER item.

Rotary Pumps (Item 28)

Cut-Away drawings of six different types of IMO-rotary pumps are included in De Laval Steam Turbine Company's catalog "LG." The IMO pump is designed to handle residual and distillate fuel oils, crude oils, all grades of lubricating oils, hydraulic oils, viscous fluids and liquids of similar characteristics. It is particularly well suited to oil burner, pressure lubrication and hydraulic pressure services. Capacities range from 0.5 to 1000 gpm. for pressures to 500 psi. and capacities to 150 gpm. for pressures to 1500 psi.

For a copy of the bulletin write De Laval Steam Turbine Company, Trenton 2, N. J., referring by number to this PETROLEUM REFINER item.

Lighting Units (Item 29)

"Benjamin Lighting Equipment for Industry and Commerce," a catalog bulletin of Benjamin Electric Manufacturing Company contains data on the new "Sky-Glo" luminous louvered system for offices and commercial locations, descriptions and specifications of lighting units for outdoor lighting of yards; explosion-proof and dust-tight units for hazardous-location lighting; and fluorescent units for the proper lighting of all types of industrial work areas, etc.

For a copy write Benjamin Electric Manufacturing Company, Des Plaines, Ill., referring by number to this PETROLEUM REFINER item.

Gearmotors (Item 30)

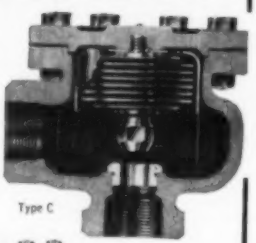
Gearmotors are featured with double and triple reduction units in Book No. 1815A of Link-Belt Company. Illustrations and dimensions are given for other features including the motor which is mounted concentrically in line with the output shaft. Sizes, minimum sprocket wheel diameters, and maximum permis-

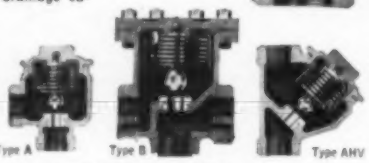
Leading Processor

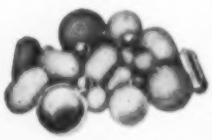
SHORTENS OPERATION from 65 to 45 Min.

With Nicholson Steam Traps

Records of a recent installation of Nicholson steam traps, by a large food packer, show they cut cooking time 30%; e.g., one operation was shortened from 65 to 45 min. Nicholson units keep equipment full of live steam because: 1) they operate on lowest temperature differential; 2) have 2 to 6 times average drainage capacity. Also record low for steam waste; and maximum air-venting capacity. Widely specified for preventing damage to thin gauges; eliminate cold blow in unit heaters.


Type C


Type A Type B Type AHV



5 TYPES FOR EVERY PURPOSE — Size ¼" to 2"; press. to 225 lbs. BULLETIN 1047.

HIGH-PRESSURE FLOATS — Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 348.

W. H. NICHOLSON & CO., 207 Oregon St., Wilkes-Barre, Pa.

sible overhung loads are included in selection tables. Diagrams and arrangement numbers for right and left hand, floor, ceiling and wall mountings are under the dimension drawings of the double and triple reduction gearmotors.

For a copy write Link-Belt Company, 307 N. Michigan Avenue, Chicago 1, referring by number to this PETROLEUM REFINER item.

Pyrometer (Item 31)

Featuring a 4-inch direct reading indicator mounted in a rubber cushioned housing, the new pyro surface pyrometer, developed by The Pyrometer Instrument, Company, Inc., "meets the rising demand for an inexpensive yet accurate and universally adaptable method for determining surface and sub-surface temperatures in industrial plant or laboratory." Two distinct series of models offer either a rigid extension arm or a long 42-inch flexible arm suitable for use with any one or more of a selection of eight types of available thermocouples. Each series of instruments is available in four temperature ranges from 0-400° F. to 0-1200° F. and all thermocouples may be interchanged without adjustment or recalibration. The instrument is further described in Catalog 180.

For a copy write The Pyrometer Instrument Company, Inc., Bergenfield, N. J., referring by number to this PETROLEUM REFINER item.

Acid Proof Pipe (Item 32)

Heil Process Equipment Corporation discusses the problem of installation of piping in plants in Heiline News, Volume II, No. 1, explaining methods of acid and alkali proof lining pipe. Also explained is the lining of fittings and fume ducts by corrosion resistant materials such as plast-o-line tank lining, carbalt plastic, acidon acid-proof paint, alkalon coating, oxid-on to seal rust, acid-proof cement No. 77, and Heilac chemical resistant lacquer.

For a copy write Heil Process Equipment Corporation, 12901 Elmwood Avenue, Cleveland 11, Ohio, referring by number to this PETROLEUM REFINER item.

Fired Air Heaters (Item 33)

Bulletin No. 600 features Peabody Engineering Corporation's direct fired air heater used in spray drying, tunnel drying odor eliminating. The heater can be installed for horizontal vertical upward or vertical downward firing with the inlet and outlet connections sized to fit present ducts. The heater consists of a refractory lined cylindrical steel encased furnace contained within a pressure tight vessel, designed to permit flow of air through the annular space between the furnace and outer shell.

For a copy write Peabody Engineering Corporation, 580 Fifth Avenue, New York 19, referring by number to this PETROLEUM REFINER item.

Precoat Filter (Item 34)

A schematic arrangement for a typical precoat filter, its principle of operation, and advantages, and other types of precoat filters are contained in Bulletin 217 of Oliver United Filters Inc., designers and manufacturers of continuous vacuum, continuous pressure and batch pressure filters. Forty-five products which the filters can handle are also listed.

For a copy of the bulletin write Oliver United Filters, Inc., 33 W. 42nd Street, New York, referring by number to this PETROLEUM REFINER item.

Deaeration (Item 35)

A revision of the publication 3005 entitled "Cochrane Deaerators," announced by Cochrane Corporation, combines the information on the importance of deaeration to feedwater chemistry, with a description of deaerating equipment. Also included is a comprehensive study of the deaeration principle, together with an article titled "The Role of Alkalinity in Preventing Corrosion."

For a copy write Cochrane Corpora-

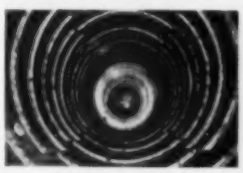
STAINLESS STEEL

Stainless Steel Evaporator and Stack

- STAINLESS STEEL VESSELS
- STAINLESS STEEL CLAD VESSELS
- STAINLESS STEEL LINED VESSELS

Rolling Stainless Steel on our large rolls. (Roll capacity, up to 2" thickness and widths up to 22')

Our complete facilities are available for stainless steel fabrication to meet your requirements, regardless of size. The main fractionating column shown above was fabricated from ⅜" plus 5/64" stainless clad steel and is 9 feet in diameter by 124 feet long. Just one of the many stainless steel projects handled at McNamar. Write or call 2-6293 in Tulsa for complete information about our unlimited facilities.



Installing Stainless Steel Tray Support Rings

McNamar Products

REFINERY TOWERS • STORAGE TANKS • ACCUMULATORS—SEPARATORS • HEAT EXCHANGERS • PIPING—STRUCTURAL SHAPES • MISCELLANEOUS REFINERY VESSELS.

McNamar Facilities

70-TON CRANE • ROLLS 2" PLATE THICKNESS • X-RAY EQUIPMENT • NATIONAL BOARD INSPECTION • AUTOMATIC WELDING • API-ASME CODE WELDING • STRESS RELIEVING SAND BLASTING.

McNamar Boiler & Tank Co.

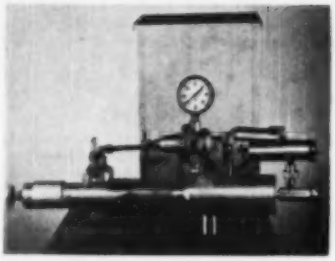
REFINERY SALES DIVISION • BOX 868, TULSA, OKLAHOMA

tion, 17th Street & Allegheny Avenue, Philadelphia 32, or Canadian General Electric Company, Ltd., 212 King Street West, Toronto, Ontario, referring by number to this PETROLEUM REFINER item.

Chemical Injector (Item 36)

Two ounces to 20 gallons of light or heavy fluids can be injected in a 24-hour period with a new chemical injection pump. Speed range of the pump is from 5 to 150 strokes per minute with a normal operating speed of 60 strokes per minute. Operating pressure range is from 0 to 60 pounds per square inch, with normal operating pressure 30 psi.

The main piston and valve are the only two moving parts. The pump has a positive one inch stroke which provides constant injection of fluid. The injector is 24 inches long, five inches wide, and 12 inches high. It is equipped with or without a five-gallon capacity stainless steel chemical tank.



The pump has a 2½-inch main cylinder and a 1¼-inch return cylinder. Standard pump has a 3/16-inch plunger with a ratio of 140:1. Accessories include a ¼-inch Norgren air regulator with gauge and a McFarland positive sight feed.

For additional information, write McFarland Manufacturing Company, 1630 Roberts Street, Houston, referring by number to this PETROLEUM REFINER item.

Fire Pumps (Item 37)

Two basic types of Underwriters' approved centrifugal fire pumps, together with selection charts, necessary fittings and application data are described in Bulletin B-1500 of the Peerless Pump Division of Food Machinery and Chemical Corporation. Both single stage and two-stage fire pumps and their methods of drive and application are covered, both in illustration and text. Dimension drawings and dimensional data are given for both types of pumps. Necessary fittings for all approved fire pump installations, with detailed text on hose valve heads, blind flanges, overflow cones, eccentric suction reducers, concentric discharge increasers, and relief valves, are also described. The bulletin also shows installation of types of pumps.

For a copy write Peerless Pump Division, Food Machinery and Chemical Corporation, 301 West Avenue 26, Los Angeles 31, referring by number to this PETROLEUM REFINER item.

Isotopes (Item 38)

"Consolidated-Nier Isotope Ratio Mass Spectrometer, Model 21-201," a bulletin published by Consolidated Engineering Corporation, covers the application of the instrument to the use and measurement of Stable rare isotopes. Both the isotope-tracer technique and the isotope-dilution technique are explained and a list of typical stable isotopes and their uses is given. Other sections explain how the instrument works, etc.

For a copy write Consolidated Engineering Corporation, 620 N. Lake Drive, Pasadena 4, Calif., referring by number to this PETROLEUM REFINER item.

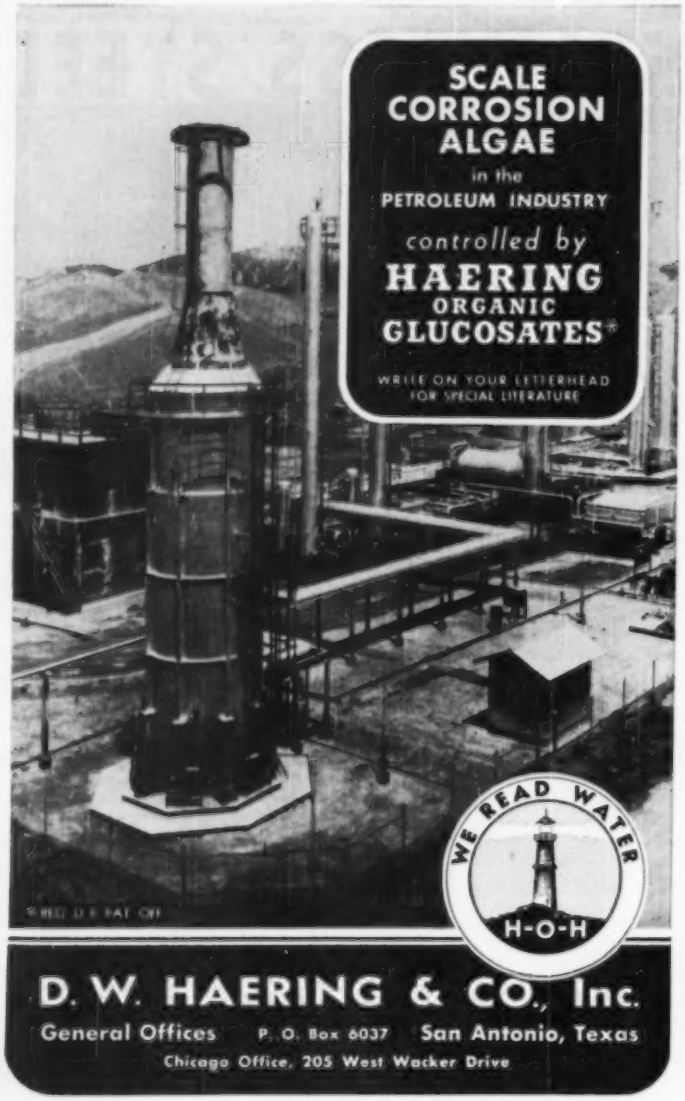
Valves (Item 39)

Quick-operating valves for general services are described in Bulletin E-160 of Everlasting Valve Company. Design and construction of these valves is explained along with their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe lines.

For a copy write Everlasting Valve Company, 49 Fisk Street, Jersey City 5, N. J., referring by number to this PETROLEUM REFINER item.

Gas Pumps (Item 40)

Roots-Connersville Blower Corporation's Bulletin 31-B-17, covers its Type XA gas pumps, used as boosters or exhausters and built in 18 standard sizes with capacities ranging from 5 to 620 cfm. at pressures up to 2 pounds, from 5 to 320 cfm. up to 4 pounds, and from 5 to 175 cfm. up to 6 pounds. The booklet discusses advantages of the



rotary positive principle. Sectional views and a chart graphically illustrate volume and power characteristics of constant pressure and variable-speed, multi-speed, or constant-speed drives. Illustrations show a variety of drives.

For a copy write Roots-Connersville Blower Corporation, 900 West Mount Street, Connersville, Ind., referring by number to this PETROLEUM REFINER item.

Concrete Floors (Item 41)

The Masterplate floor, with its iron armored surface about one-eighth inch thick is claimed to wear at least 5-6 times longer than a plain concrete floor. Directions for laying a new floor and resurfacing an old one are given in The Bayless-Kerr Company booklet, "The Masterplate Iron-Clad Concrete Floor." This type flooring is "spark resistant, static disseminating, non-dusting, and corrosion resistant."

For a copy write The Bayless-Kerr Company, 1166 Hanna Building, Cleveland 15, Ohio, referring by number to this PETROLEUM REFINER item.

Indicators (Item 42)

Temperature indicators including cold-end compensated thermocouple thermometers for measuring temperatures up to 3000° F., and resistance thermometers up to 300° F. have been announced by General Electric Company. Described in Bulletin GEC-565, both types can be supplied in either square or round molded Textolite cases. The thermocouple thermometer is available in 3½ or 2½-inch flange. The resistance thermometers, designed for measurement of low temperatures where high accuracy is important, are available in long-scale instruments, six-inch rectangular, surface and flush-mounted instruments.

For a copy of the bulletin write General Electric Company, Schenectady 5, N. Y., referring by number to this PETROLEUM REFINER item.

Trash Pump (Item 43)

Fairbanks, Morse & Company's bladeless trash pump is claimed to handle larger trash, particularly of the fibrous type—as the rags, cloth, pieces of tarpaulin and canvas shown in the cut—than will conventional sewage pumps having blades in the impeller. Fluid passes through the impeller through a single rotating channel or passage way with the centrifugal force doing the work. Other advantages claimed are reduced attention in maintenance; and use of smaller driving motors. The pump which "has been tested extensively" is available in sizes from 2 to 5 inches.

For further information write Fairbanks, Morse & Company, 600 South Michigan Avenue, Chicago 5, referring by number to this PETROLEUM REFINER item.

Heating Units (Item 44)

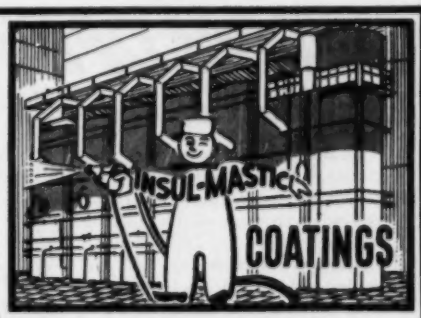
A new heating unit that can be used inter-changeably as a steam boiler or hot water heater by adapting the control equipment accordingly, is introduced in "Here's News," a bulletin of Black, Sivalls and Bryson, Inc. The Bulletin illustrates the principle of internal firebox construction along the lines of the Scotch marine boiler. Drawings show recommended hook-ups for the unit as a 15-psi. working pressure steam boiler and as a 40-psi. working pressure hot water or fluid heater.

For a copy write Black, Sivalls and Bryson, Inc., 720 Delaware, Kansas City 6, Mo., referring by number to this PETROLEUM REFINER item.

Cement Chart (Item 45)

A chart showing the resistance of both resin and silicate cements to various corrosive chemicals, issued by the special chemicals department of Pennsylvania Salt Manufacturing Company, is designed as a tool to aid the corrosion resistant masonry construction trade in

"LET'S GET DOWN to BRASS TACKS"



A well known testing laboratory* has reported that Insul-Mastic has a maintenance-free-life approaching fifty years. An eight year continuous test in a Weather-O-Meter (equivalent to approximately 57 years outside weather) has corroborated this finding. Other laboratory tests and actual jobs have shown hat severest conditions do not affect the durability of Insul-Mastic.

Why not get "down to brass tacks" with our engineers and discuss your coating problems.

*Name on request.

Insul-Mastic Coatings can serve you in these four basic ways:

- Preventing corrosion.
- Vaporseal over thermal insulation.
- Cork-mastic insulation.
- Waterproofing and resurfacing.

Insul-Mastic Corporation OF AMERICA
OLIVER BUILDING • PITTSBURGH 22, PENNSYLVANIA

selecting the proper cement for specific industrial uses. It shows resistance of Pennsalt PRF, Asplit, Causplit, Pennsalt HF, and Penchlor acid proof cement to a list of 259 chemicals and compounds from acetaldehyde to zinc sulfate.

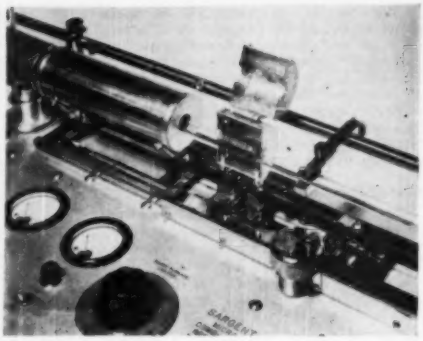
For a copy write Special Chemicals Department, Pennsylvania Salt Manufacturing Company, 1000 Widener Building, Philadelphia 7, referring by number to this PETROLEUM REFINER item.

Adjustable Speed (Item 46)

General Electric Company is offering five new publications on adjustable speed. They are "Adjustable Speed" (GEA-5334); "Adjustable-Speed ACA Motors" (GEA-4883A); "Speed Variator" (GEA-5335); "Electronic Speed Variator" (GEA-5336); and "Thy-Mo-Trol (electronic motor control system) Adjustable-Speed Drives" (GEA-5337). The first booklet includes industrial benefits of adjustable speed; selection guide for an adjustable-speed drive, case histories, advantages, etc. The booklet includes ac. and dc. adjustable-speed drive motors, packaged adjustable-speed drives, and various electronic devices which provide adjustable speed. The other four publications contain features, advantages, operating characteristics, and ratings, of specific equipment.

For copies write General Electric Company, Schenectady 5, N. Y., referring by number to this PETROLEUM REFINER item.

Moving Furnace (Item 47)



A micro and semi-micro combustion apparatus, and a separate 7-inch furnace for use in miscellaneous train assemblies, both employing the principle of radiant transmission, have been announced by E. H. Sargent & Company. The apparatus was especially designed for use with halogen and sulfur and where a large volume of elementary analysis for carbon, hydrogen and nitrogen in rare organic compounds is performed. Shown here is a close-up view of the micro combustion apparatus moving furnace, 7 inches long. It will travel 4 or 12 millimeters per minute and will operate at a maximum temperature of over 850° C. The maximum power consumption is 175 watts, as compared with 275 watts of the long furnace. Furnace is mounted on a case with panel containing meter, switch, pilot light and variable transformer control for desired temperature.

For further information write E. H. Sargent & Company, 4647 W. Foster Avenue, Chicago 30, referring by number to this PETROLEUM REFINER item.

Iron Works (Item 48)

The facilities of Posey Iron Works, Inc., employing six divisions—steel plate, brick machinery, iroquois, foundry, industrial heating and steel form—and covering 16½ acres, are described in a company bulletin. These divisions produce over 50 pieces of equipment.

For a copy write Posey Iron Works, Inc., Lancaster, Pa., referring by number to this PETROLEUM REFINER item.

Centrifuge (Item 49)

Operating details, specifications and application data for the complete line of Sharples Super-Centrifuges has been released in Bulletin No. 1248 published by The Sharples Corporation. The bulletin includes basic information on the centrifuge principle, maximum utilization of centrifugal force, operating features, and specifications on all forms and models, both for general and specialized industrial application. Also included are details of Enbloc purifiers, laboratory and portable super-centrifuges in open-type and Vaportite designs.

For a copy write The Sharples Corporation, 2364 Westmoreland Street, Philadelphia 40, referring by number to this PETROLEUM REFINER item.

Boron Trifluoride (Item 50)

"Boron Trifluoride and Its Derivatives" is a monograph of John Wiley & Sons, Inc., featuring condensation and polymerization reactions in which boron trifluoride is used as a catalyst. The current knowledge of boron trifluoride and its wide commercial applications is also discussed, along with the use of boron trifluoride to form coordination compounds which can be used in catalysis. A bibliography is provided.

For a copy write John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, referring by number to this PETROLEUM REFINER item.

Combustion Controllers (Item 51)

Selas Corporation of America's bulletin on combustion controllers describes their applications in the heating of materials in the course of manufacture, or generation of special atmospheres to protect those materials during heat application. The controller exercises both physical and chemical control over chemical reactions. Controllers are also used for diluting liquefied petroleum gases to provide substitute fuels and for accurately mixing any two noncorrosive gases. Also discussed are controller design and construction, principle of operation, capacities and pressures, accessory equipment, and controller selection procedure.

For a copy write Selas Corporation of America, Philadelphia 34, referring by number to this PETROLEUM REFINER item.

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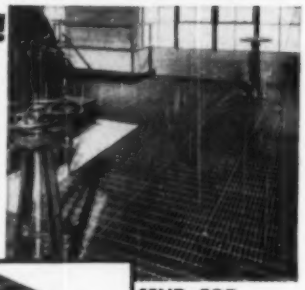
IT'S Blaw-Knox *Electroforged* Steel Grating! *Exceptionally strong,* electroforged into one solid piece. *Non-slip* twisted bar for safe, sure footing. Maximum open area. Self-cleaning, no sharp corners to clog. Easily installed and easily maintained. Adaptable to many uses, indoors and out, for every industry.



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Open flooring
Sidewalk doors
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Sidewalks
Stair treads
Many other uses

Blaw-Knox Electroforged Stair Treads. Three types available: Rolled diamond checker plate nosing (illustrated), twisted cross-bar nosing, or abrasive nosing.

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SERIES 700V
DIAPHRAGM CONTROL VALVE
WITH VENTURI THROAT

HIGH fluid velocities . . . even viscous fluids and fluids containing suspensions . . . are pushovers for the Series 700V. A special venturi throat eliminates the sudden change in direction of flow so often the cause of trouble under such conditions. As a result, in-service time is unusually high.

OUTSTANDING FEATURES OF THE 700V

- *Special flushing connection to keep stem operation free.*
- *Special materials for body and trim to meet prevailing operating conditions.*
- *Special design, renewable disc and seat ring.*
- *Special provision for field conversion from straight through to angle operation.*

You'll save a lot in maintenance costs alone, if you standardize on the Series 700V for high fluid velocities. Call in your local Honeywell engineer for complete information . . . he is as near as your phone!

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WORLD'S LARGEST ORGANIZATION FOR ADVANCED INSTRUMENTATION AND CONTROL

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BELFIELD VALVE DIVISION
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Offices in 73 principal cities of the United States, Canada and throughout the world

Diaphragm Valves
AND PROCESS CONTROL SPECIALTIES

About EQUIPMENT and SERVICE Suppliers

US Steel Subsidiaries Make Executive Changes

Charles R. Cox has resigned as president of Carnegie-Illinois Steel Corporation, Pittsburgh, to become president of Kennecott Copper Corporation, New York. Cox was awarded the "Certificate of Merit," signed by President Truman for his "outstanding services during the recent war in increasing the production both of steel and of finished products; in making great improvements in blast furnace operations . . ." Cox succeeds E. T. Stannard, as Kennecott president.

Hood

Clifford F. Hood, president of American Steel and Wire Company, Cleveland, succeeds Cox as president of Carnegie-Illinois Steel Corporation, Pittsburgh. Hood, with American Steel and Wire Company since 1917, started as an operating clerk.

Harvey B. Jordan, vice president in charge of operations of American Steel and Wire Company has been elected president, replacing Hood. Jordan has been with the company 35 years.

James E. Lose, vice president in charge of operations, Carnegie-Illinois Steel Corporation, Pittsburgh, has been elected executive vice president, the first official to occupy this newly-created position with the company. Lose began his career with Carnegie Steel Company, one of the predecessors of Carnegie-Illinois Steel Corporation, in 1910.

Lunken's Name Omitted

In a December PETROLEUM REFINER item the name of Homer E. Lunken was inadvertently omitted from a list of officials of The Lunkenheimer Company, Cincinnati, Ohio. Mr. Lunken is vice president and assistant general manager of the firm. On January 3 Paul M. Arnall became vice president and general manager.

SAVE WITH LENAPE STUDDING OUTLETS

Studding outlets, naturally short in height and providing reinforcement of the opening, have design appeal, economy in price and fabrication, and advantages in use.

Important applications include inter-deck access openings on small diameter towers or columns, boiler mountings, clean-out or observation ports, and similar uses in close-clearance locations.

Welding type studding outlets in wide range of sizes and ASA standards, and riveting type in 150lb. and 300lb. Standards are detailed in Catalog 9-49.

While available in mild and Stainless steels, sizes 6" and larger can be furnished stainless lined and faced for best economy on clad or solid stainless constructions.

WELDING TYPE

WELDING TYPE

RIVETING TYPE

LENAPE HYDRAULIC PRESSING AND FORGING CO.

LENAPE HYDRAULIC PRESSING & FORGING CO.
DEPT. 106 WEST CHESTER, PA.

Selas Names West Coast Agent

Frederic O. Hess, president of Selas Corporation of America, has announced the appointment of Stuart A. Whitehurst as representative of the Pacific coast area. Whitehurst, whose headquarters will be at 11168 Santa Monica Boulavard, Los Angeles 25, has been associated with industrial designing and operation for the past 27 years. He has also been active in the field of sales engineering.

Whitehurst

Selas Corporation of America, consulting and manufacturing heat process engineers, is headquartered in Philadelphia.

Minneapolis-Honeywell Personnel in New Posts

Creation of a new management sales post and promotions of four branch and regional managers have been announced by Minneapolis-Honeywell Regulator Company as follows:

Fred Kaiser, midwest regional manager since 1942, has been promoted to the new position of field sales manager. Clarence L. Peterson, Pacific regional manager in San Francisco, will succeed him.

Succeeding Peterson as Pacific regional manager is Gavin S. Younkin, Los Angeles branch manager since 1943. Younkin will continue to headquarter in Los Angeles. Reginald C. Cushing, with Honeywell since 1935, has been promoted to branch manager of the company's San Francisco office.

Allegheny Ludlum Steel Makes Executive Changes

Executive staff changes for Allegheny Ludlum Steel Corporation have been announced as follows: H. G. Batcheller, company president, has been named chairman of the board, with E. B. Cleborne, executive vice president, succeeding him as president. Cleburne was succeeded by Edward J. Hanley, vice president in charge of finance and treasurer. Clark W. King, vice president, was elected treasurer, succeeding Hanley. T. Ames Wheeler, manager of the costs and statistics department, has been elected to the newly created office of controller.

Resignations in the board of directors include William E. Ruder and John W. Belandger, directors. King and Russell M. Allen, vice president in charge of sales have been named to succeed Ruder and Belanger. William J. Kyle, partner in the law firm of Smith, Buchanan and Ingersoll, will replace James O. Carr, deceased, as director.

Canadian Firm De Laval Agent

The Superheater Company, Ltd., of Montreal, Can. (in conjunction with its affiliate, Combustion Engineering Corporation, Ltd.) has been appointed to represent De Laval Steam Turbine Company of Trenton, N. J. The Superheater Company, Ltd., will sell and service De Laval turbines, pumps, gears and compressors in the provinces of Newfoundland, New Brunswick, Nova Scotia, Prince Edward and Quebec.

Rockwell Manufacturing Names Eastern District Managers

Rockwell Manufacturing Company has announced the appointment of J. W. Northcutt as Atlanta district sales manager to succeed C. C. Moore, transferred to the new district office in Columbus.

Northcutt

Northcutt joined the Tulsa office in 1936, becoming sales engineer for company products in the Corpus Christi area. Prior to his present assignment, he handled all major oil and engineering company accounts in the Houston district.

Moore was affiliated with Lynchburg Foundry Company, Lynchburg, Va., for ten years before joining Mesta Machine Company, Pittsburgh, in 1923. He also operated his own selling agency until 1930 when he became manager of meter parts for Pittsburgh Equitable Meter Company. Moore was Atlanta district manager since 1943 until his recent transfer.

Laclede-Christy Acquires Diamond Fire Brick Plant

Laclede-Christy Company, whose general sales offices are in Pittsburgh, has acquired the capital stock of Diamond Fire Brick Company of Canon City, Colo., giving it its fourteenth manufacturing unit, of which it owns eight and is affiliated with six. The new plant produces fire-clay brick and silica brick.

The deal was consummated largely through a cash transaction. Controlling interest formerly was held by American Arch Company of New York, which is being liquidated.

J. L. Cummings of Pittsburgh has been elected executive vice president and D. M. Rice of St. Louis, vice president and general manager.

Besides the newly acquired plant at Canon City, the company has taken over three other plants in the past five years, including one at Birmingham, Ala.; Osceola Mills, Pa.; and Warm Springs, Calif.

Allis-Chalmers Names Dealers For West South Central Area

New dealers for Allis-Chalmers Manufacturing Company's motors and controls in the West South Central area are Hudson Motor Exchange, Ponca City, Okla., and Wholesale Electric Supply Company, Houston.

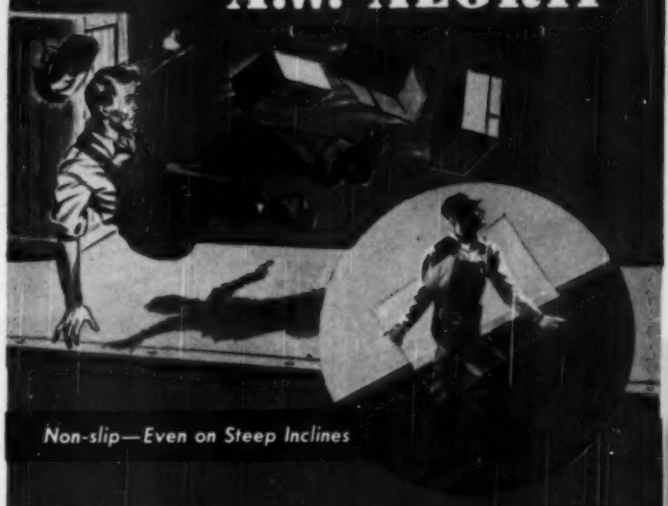
Hudson Motor Exchange, organized in 1938, is also dealer for Allis-Chalmers transformers in several Oklahoma counties. J. A. Hudson is owner of the firm.

Wholesale Electric Supply Company also is dealer for Allis-Chalmers circuit breakers in six counties in Louisiana and for a Southeastern Texas area.

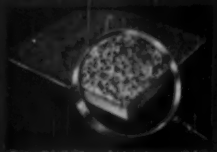
A. A. Borgading Launches Own Firm as Manufacturers Agent

Alborg Supply and Equipment Company, a new firm of manufacturers' representatives specializing in industrial purchasing services for the railroad, oil production, refining, and marine construction fields, has been organized with Alvin A. Borgading, former vice presi-

A.W. ALGRIP



Non-slip—Even on Steep Inclines



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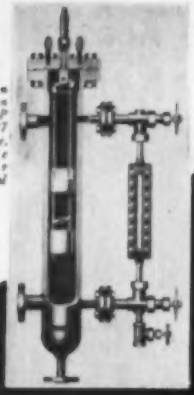

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Fred Thilenius Appointed France Packing Manager

For their newly created Mid-Continent district, France Packing Company has appointed Fred Thilenius manager, with offices in Tulsa. The new district office will serve as sales headquarters for Kansas and Oklahoma, north and West Texas, including the Panhandle and southeast New Mexico.

Thilenius

Thilenius has served the company as sales representative for some time and has been identified with the petroleum industry most of his life as field engineer, district engineer, master mechanic and division superintendent of pipe lines. He has also had sales experience as representative with several leading companies for more than 13 years. Thilenius is a graduate of Washington University, St. Louis.

Foxboro Appoints Temple For Baton Rouge Office

The Foxboro Company has appointed Joseph M. Temple, as manager of the branch office at Baton Rouge, La., to succeed John B. Deaderick, now manager of the Tulsa office.

Temple received his education in mechanical engineering at Louisiana State University. He has been sales engineer with J. B. Beaird Company, of Shreveport, metal fabricators for petroleum refining and the other heavy industries and before the war was associated with Petroleum Engineering, Inc., at Houston as field engineer and plant superintendent.

Worthington Service Manager

Kenneth A. Field has been appointed service manager of Worthington Pump and Machinery Corporation's Wellsville, N. Y. works. Field holds a B.S. degree in mechanical engineering from the University of Maine and has done graduate work at the Illinois Institute of Technology. He joined the company in 1945 and was previously employed by Allis-Chalmers Manufacturing Company.

Stacey Dresser Moves To Cincinnati Office

Stacey-Dresser Engineering Division, Cleveland, Ohio, is in the process of moving its headquarters to Cincinnati, according to an announcement of H. N. Mallon, president of Dresser Industries, Inc.

E. A. Flaschar, general manager of Stacey-Dresser will direct the coordination of the activities of his organization with those of its parent company, Stacey Brothers Gas Construction Company, a subsidiary of Dresser Industries, Inc. The address of Stacey-Dresser Engineering Division becomes the same as that of Stacey Brothers, P. O. Box E (5535 Vine Street), Cincinnati 16.

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Graver Water Conditioning Adds Sales Engineering Agents

In its sales expansion program, Graver Water Conditioning Company, a division of Graver Tank & Manufacturing Company, Inc., has appointed three of the parent company's engineering representatives as its sales agents: J. R. Fortune & Son, Detroit; The Stapp Engineering Company, Denver, and Process Equipment Company, Tulsa.

These agents have developed facilities for handling engineering work, detailed drafting, and erection of installation. They will handle the company's line of water conditioning equipment, including hot and cold process water softeners, zeolite water softeners and demineralizers, deaerating heaters, chemical feeders, and filters for removal of taste, odor, oil, iron and silica, etc., from water.

National Tube Appoints Two Managers of Sales

Harry L. Bialock, manager of sales of National Tube Company at Atlanta, Ga., succeeds David T. Marvel, resigned, as manager of sales of the tubing specialties division of this United States Steel subsidiary. Bialock's headquarters will be at Gary, Ind. He is succeeded by Charles J. Lundvall, former salesman in the New York district office.

Bialock, with the company since 1936, became a salesman in the New Orleans office and later manager of sales. He was a tubing specialty representative in Washington, D. C., during the war, and is a graduate of Washington University Law School, St. Louis, Mo.

Lundvall joined the company in 1926, and has been a salesman and field engineer since 1930. He attended Northwestern University and Iowa State University. In his new position, Lundvall heads sales of all products in North Carolin, South Carolina, Florida, Georgia, Alabama, and eastern Tennessee.

Brown Training School Offers Courses in New Instruments

Instruction in new and improved types of industrial measuring, indicating and controlling instruments will be given in the industrial instrumentation training school schedules to be conducted for the first six months of 1950 by Brown Instruments division of Minneapolis-Honeywell Regulator Company.

Included will be four short courses of five weeks each and one long course of 13 weeks. In addition to the short courses for customer's men, to be held during January-June, courses will be held for specific industries. The first short course will open January 9 and end June 30. The regular comprehensive 13-weeks course will start February 27 and end May 26.

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Thirty years of successful selling in Western New York, Pennsylvania, Ohio, West Virginia and Kentucky; all experienced and able personnel; technical knowledge and proven salesmanship; oil refinery, chemical plant and gas industry contacts. We are interested in representing company whose products are applicable to above industries. Address: Box 166R, c/o Petroleum Refiner, Houston, Texas.

Spang-Chalfant Division Names Booth General Sales Manager

Booth

The National Supply Company has appointed Edwin A. Booth as general manager of sales of the Spang - Chalfant division. He has been with the company since 1929.

Booth is a graduate of Pennsylvania State College. Before his recent appointment, he was manager of the Pittsburgh sales district.

Hammond's Boston Agent

Hammond Iron Works of Warren, Pa., has appointed Thomas F. Fitzgerald as engineering sales representative in the Boston area. Fitzgerald is acquainted with the requirements of the petrochemical industries in relation to Hammond Iron Works products and services including the design, fabrication and erection of storage tanks of cone roof, breather, sphere, spheroid, floating roof and vapor-lift design; gas holders, pressure vessels, general plate work in steel, stainless, stainless-clad and aluminum.

Instrument Company Acquires New Thermometer Business

The thermometer business of American Thermometer Company, St. Louis, Mo., has been purchased by H-B Instrument Company of Philadelphia with all facilities at St. Louis transferred to Philadelphia.

The demands of industry can better be served by one source for the wide variety of mercury-in-glass and organic liquid filled thermometers required today, according to H-B Instrument Company which can now offer metal or wood frame thermometers for cooking, baking, incubator, brooder, refrigerator, tobacco curing, brine, air duct and diesel engine temperatures. These will be sold, in the future, under the H-B double diamond registered trademark.

French Firm to Manufacture Wheelco Instruments Products

Wheelco Instruments Company, manufacturers of electronic controllers, recorders and combustion safeguards, has signed a licensing agreement with a French instrument manufacturer. The capacitrol, electronic controller, will be manufactured by La Pyrometrie Industrielle, Paris, and the flame-otrol, combustion safeguard, by their subsidiary Le Controle de Chauffe, Bagneux, France. Terms of the license permit distribution of these two instruments in France, Spain and Portugal.

Appointed Sales Agent

G. L. Gabrielson has been appointed sales agent in the Pittsburgh office of American Car and Foundry Company. He was formerly with the miscellaneous products division of ACF's sales department in New York.

MAINTENANCE CREW HANDS OFF!

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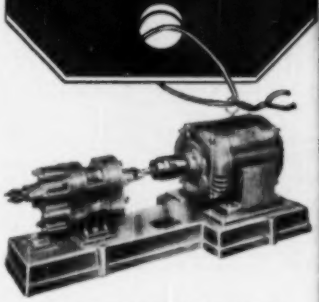
SIER-BATH ROTARY PUMP



Sier-Bath Screw Pumps and Gearex Pumps are designed to do a job—and keep doing it. The manufacturer has a full appreciation of the high cost of interrupting the operation of a line to permit pump repairs. On the Internal Gear-type Screw Pump, for example, the gland is the only point of attention and as this is on the suction side, it is almost negligible. It is not unusual for the packing to last two years without repacking. The pressure on the gland is so slight that it is possible to add a new ring of packing without shutting down the unit. Send for information.

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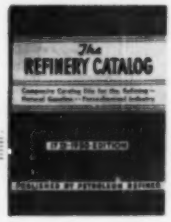

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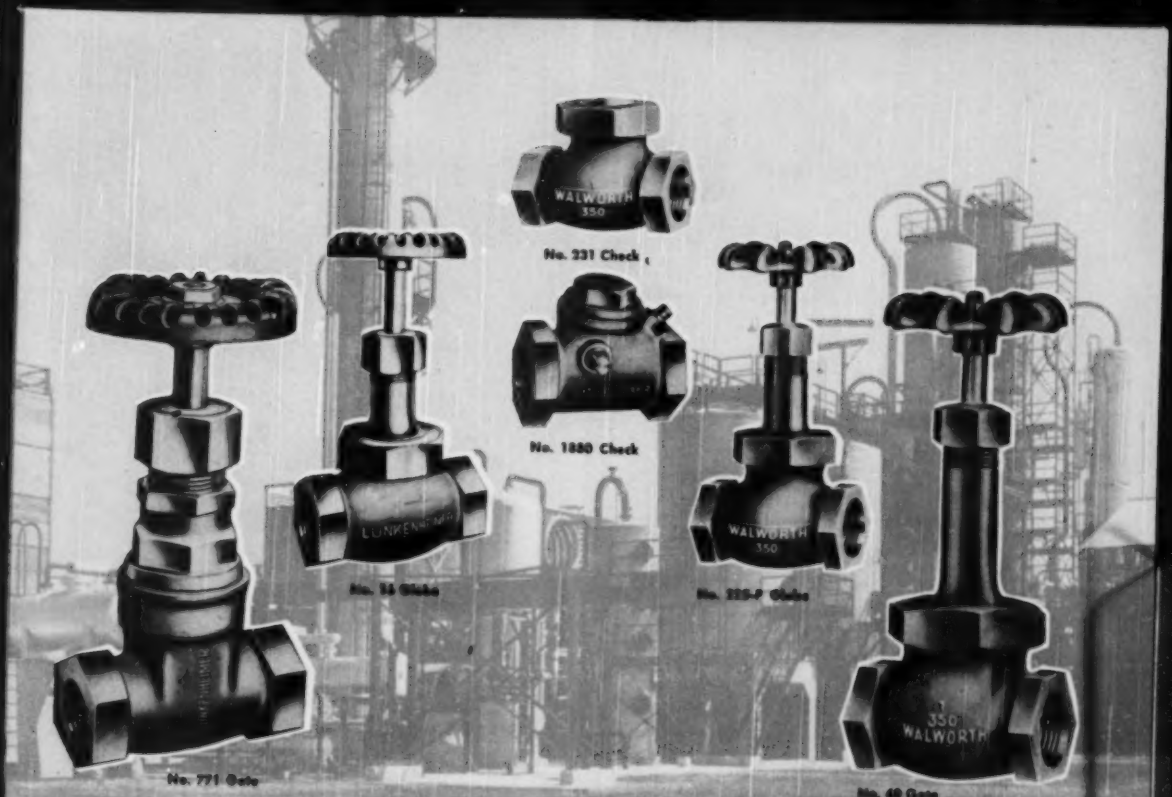

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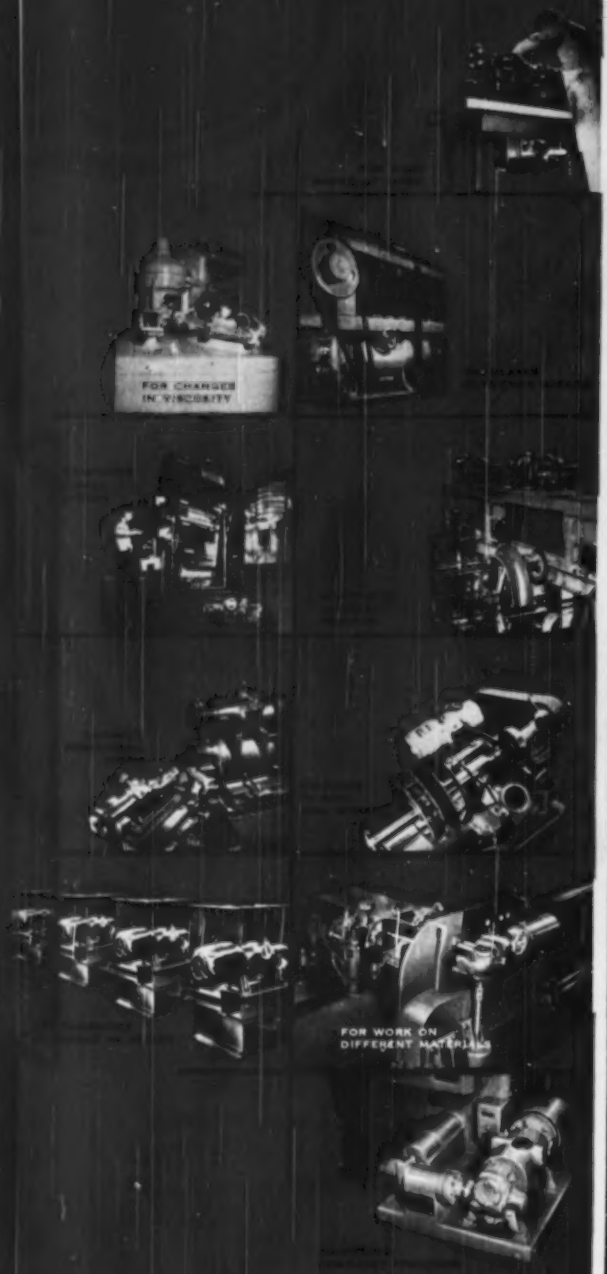

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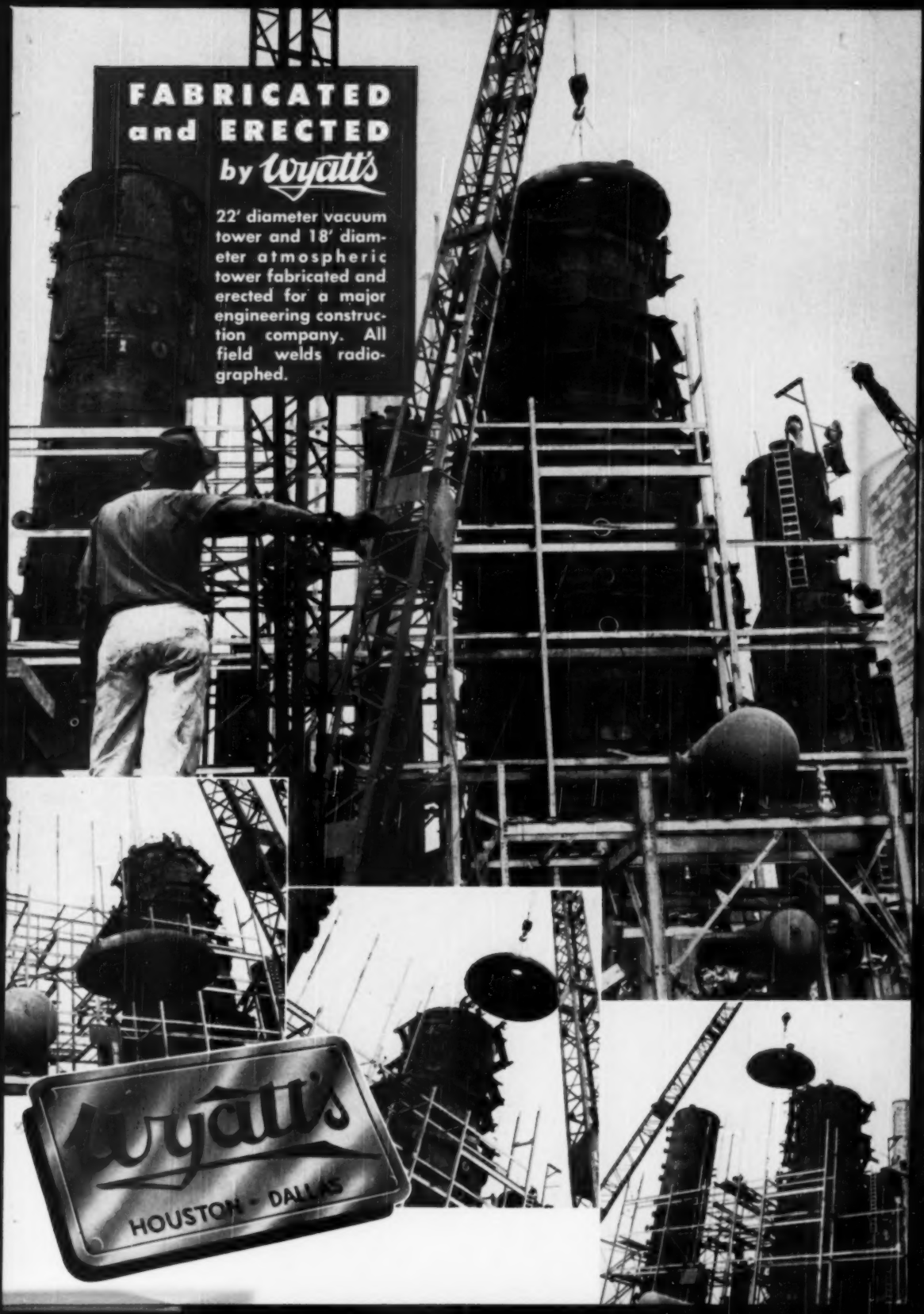
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